

English Gauged Brickwork: Historical Development and Future Practices

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ABSTRACT

ENGLISH GAUGED BRICKWORK: HISTORICAL DEVELOPMENT AND FUTURE PRACTICES

Traditional brickwork, of quality materials, well detailed, and built by good craftsmen, requires little maintenance throughout its life. Inevitably, older buildings face varying degrees of maintenance and change, including repair of brick fabric. Many of these buildings might incorporate cut and rubbed brickwork, and gauged enrichments, of architectural, historic, and social significance. It is therefore vital that cut and rubbed and gauged work is carried out in a fully informed manner so as not to adversely affect the character, integrity, and structural stability of the building.

This thesis investigates the development and the technical aspects of cut and rubbed, and gauged work, and re-examines historic materials, craft tools, and techniques that have fallen from use, and which played a significant role in the execution of post-fired worked brickwork.

The design and construction of a small-scaled gauged niche masterpiece - historically considered to be the supreme test of a craftsman bricklayer – has been undertaken using traditional materials, tools and techniques.

Historic and contemporary rubbing bricks have been tested and analysed. The cutting and rubbing performance of contemporary rubbing bricks was found to be inferior to their historic counterparts, being generally harder and more difficult to work.

Microscopic examination has shown that historic rubbing bricks were fired at lower temperatures (750-900°C) than the modern rubbing bricks (~900°C). This has led to the bricks having very different physical properties, with the historic rubbing bricks, having significantly greater porosity and water absorption than the modern.

Furthermore the historic rubbing bricks were shown to have a much finer texture, and contain significant quantities of reactive temper (chert and volcanic rock). This temper is believed to react with water to produce cements within the matrix, which may contribute to their overall durability.

The information and experience gained from this exercise, combined with the interdisciplinary findings of this thesis, provides a contextual, historical, theoretical and practical understanding of cut and rubbed, and gauged brickwork for craft professionals to assess how it can be applied today, using the best of traditional and modern methods to achieve high-quality new work or successful conservation and repair.

DEDICATION

To my late Father, James Patrick Lynch (1923-2001) (RIP).

A gentleman of great intelligence, wisdom and craftsmanship, and whose inspiration lies at the root of all that I have achieved.

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DECLARATION

The work presented in this thesis was carried out while the author was registered within the Faculty of Art and Design at De Montfort University, Leicester between February 2001 and May 2004. It represents the original work of the author.

This thesis has not been submitted for any other degree at this or any other university.

Gerard C J Lynch LCG, Cert Ed, MA (Dist)

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- To my wife, Fiona, who finalised the typing and presentation of the thesis.

Bricklayers-Work is an Art Manual, which Joins several Bodies so together, that they adhere like one entire Body.

Whether the *White Mason*, which is the Hewer of Stone, or the *Red Mason*, which is the Hewer of Brick, be the most Ancient, I know not: but in Holy Writ, we read of making of Bricks, before we read of Digging or Hewing of Stones; therefore we may suppose the *Red Mason* (or *Bricklayer*) to be the most Ancient.

Joseph Moxon (1627-91), *Mechanick Exercises or the Doctrine of Handy-works*, London, 1703.

1.0 INTRODUCTION

Gauged brickwork is an English term defined as brickwork where a superior finish in the detail of an important brickwork elevation is required, such as moulded reveals, arches, string courses and other forms of ornamentation. The term may appear paradoxical as all brickwork may be considered gauged, but it serves to distinguish a special branch of bricklaying work to very accurate measurements, which raised artisans of the craft to the status of masons. By definition, to gauge is to measure, set out, and work exactly objects of standard size so as to conform to strictly defined limits, and this term is eminently suitable for this class of brickwork.

The bricks for this class of brickwork have, in England, always been referred to as 'rubbing bricks' or 'rubbers'. There is no evidence to suggest a similar history of gauged brickwork in other parts of the British Isles. A 'rubbing brick' or 'rubber' can be defined as a masonry unit, made from a brickearth or topmost clay, possessing high natural silica content. It is low-fired, or baked, to a point just below vitrification (900°C) so the resultant burnt brick possesses no fireskin normal to other fired bricks. The rubbing brick has the same uniform characteristics of soft body and close texture throughout. This allows it to be worked in a post-fired state so that it can easily be cut, carved, filed, and rubbed (abraded) to present smooth accurate finishes and sharp arrises (edges) without detriment to its long-term durability. In England, for several centuries, this has made the rubber prized for use on all forms of enrichments where precision and fineness of joints were essential in the days that preceded the mass production of mechanised quality-controlled and regular-shaped bricks.

1.1 *Historical Perspective*

As a study by Gunther (1928, 232) reveals, the term gauged brickwork, or gauged work, appears in England during the seventeenth century. Then it defined a new class of brickwork that was an ultimate refining in quality and accuracy of working bricks in the post-fired state, and setting them, as had been practised in England from the early fifteenth century. Simpson (1960, 26) explains that in 1438-9, for example, the accounts for Tattershall Castle (Lincolnshire) records payment for 2,200 de tegulis operatis vocatis hewentile, or worked bricks called hewentile for the construction of chimneys (sadly gone) and windows in the stable. By the sixteenth century one also begins to see

references to this practice of post-fired working of bricks for enrichments as 'cutting and rubbing', such as at Hengrave Hall (Suffolk) of c.1530, which states that the cut chimneys were to be of 'roubed bryck' (Moore, 1991, 227; citing Gage, 1822, 42).

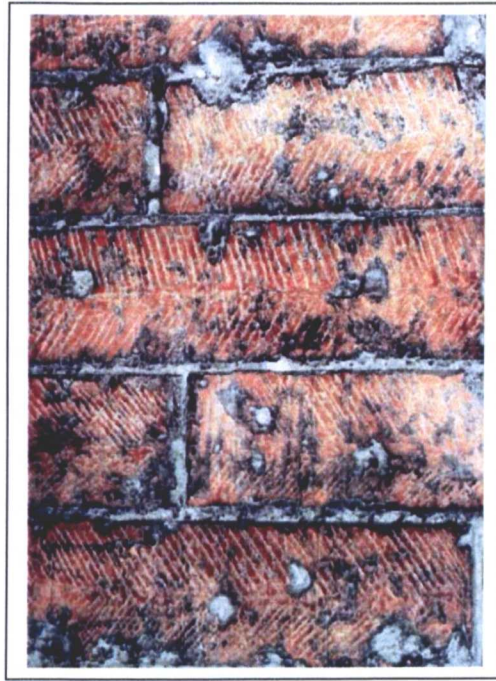
The term cut and rubbed work has remained in use from the fifteenth century through to the present, but after the Restoration was understood to refer to tightly-jointed gauged brickwork, as opposed to the earlier, less refined work set within nominal sized mortar joints.

Bricks capable of being worked in the post-fired state, before and after laying, similar to how a mason works his stone for architectural enrichments, have a long history that pre-dates Roman or Paleo-Christian times (Binda 1999; Marino, 1999).

From the great civilisations of Assyria and Mesopotamia the skills of working post-fired bricks were retained and advanced by the ancient Romans, as seen in the ruins of Ostia (the port of Rome) in late first century AD; and these skills were not entirely lost with the fall of Rome. Fine examples of dressed bricks and brickwork are still to be seen on some eleventh-century classical facades in the Tuscan region of Italy. In particular, on the facade of the church of Santa Maria Della Scala, Sienna (AD 1090), where the large bricks are precisely finished to be laid with joints averaging 6 mm. The faces of the bricks clearly reveal *in situ* finishing using some form of mason's drag in places. In other parts of the building, dressing appears to be by the use of a form of cutting tool to provide a regular herringbone pattern on the individual stretcher faces (Figure 1). Forms and decoration characteristic of stone were often imitated in brick, in many parts of Italy up to the seventeenth century, as Giovannoni (1925, xiv-xv) records:

Thus we often find at Parma, Piacenza, Modena, and Bologna...capitals executed in brick, vault ribs, window and door frames with mouldings carved in brick, as if they were stone

The influence of Italian architecture and building craft practices gradually spread to northern Europe, mainly through the work of the Cistercian order and their monastic trading links. In the Netherlands, this began to be seen first in the prosperous region of Flanders. The Cloth Hall in Brugge (Bruges) of c.1280 is mainly a brick building with stone enrichments where the overall face brickwork is 'drag'-finished exactly as the surrounding stonework dressings.



*Figure 1*Herringbone tool markings to cut brickwork in Sienna (Italy), 1090 (Joop Hofmeijer).*

Documentary evidence suggests that the skills in post-fired working of bricks to produce 'hewen' and 'roubed' enrichments in the fifteenth and sixteenth centuries were introduced into England by Flemish mason-bricklayers (Moore, 1991, 214). These craftsmen were highly proficient in this art, developed from craft practices in their native Flanders, and were being requested to work in England on important royal, merchant, or municipal building programmes, where brick was playing an ever more important role over that of stonework.

Seventeenth-century classical English gauged work had its influence, not from Flanders but the Netherlands and, in particular, the architecturally influential city of Amsterdam in the province of Holland. In the highly skilled hands of the English city bricklayers, working to the designs of great architects like Wren, Hooke, May, and Pratt in post-Restoration England, gauged brickwork became the consummate expression of the finest brick craftsmanship. Its use was, from then, to proliferate on the principal facades of the very best brick edifices.

The brickwork of the Georgian period served only to confirm the status of gauged work. Its use became ubiquitous for most dressings, such as arches, aprons, platt bands, and cornices; these being the enrichments that adorned the street-facing elevations, especially on the brick-built terraced houses for which this period is normally associated.

The early Victorian period saw a decline in the ornate articulation of brick buildings due to changing architectural tastes, the need for mass-produced cheap housing for workers in the ever-expanding industrial landscape, and the emergence of cheaper machine produced and regular-sized bricks. Only with the return to favour of fair-faced brickwork after the 1840s, particularly with the emergence of the Arts and Crafts Movement in the 1880s, did brickwork standards again rise. With the latter movement, hand-crafting practices enjoyed a revival that, in brickwork, led to gauged work re-establishing itself as the highest form of brickwork for producing architectural dressings on the show faces. This survived virtually unchallenged, until the changing economic and social circumstances in England that followed the First World War (1914-18).

The skills of gauged brickwork were less called upon as the intervening years passed, yet remained an important part of the measure of a first-rate bricklayer, and its use was not infrequent throughout the years until the Second World War (1939-45). After 1945 a need to quickly re-build the blitzed towns and cities, providing improved homes for a rapidly growing population, made use of changing construction technologies that were faster, cheaper, and required less skill. Better suited to the speed of delivery that these circumstances demanded, (compared with the slower traditional and highly skilled practices), it sounded the death-knell for the more refined areas of the noble art of bricklaying, such as expensive gauged work.

Throughout the 1950s, '60s and '70s ever more functional buildings of plain brickwork had no need of expensive bricks or handcrafted dressings. This was reflected in a reduction in the period of apprenticeships from five down to three years. With it, came the removal of the more advanced areas of craft skills and knowledge from the City and Guilds brickwork syllabus. This was accompanied by a continuing loss of traditional hand-making brickyards, especially those making rubbing bricks for the production of gauged work.

In 1990, through the publication of *Gauged Brickwork: A Technical Handbook*, the author sought to ensure that this neglected branch of the craft was returned to national prominence. In his lectures, master-classes and published work, he has emphasised the pressing need to revive the skills and knowledge of gauged brickwork for apprentices and established craftsmen denied the opportunity to learn. This initiative saw the need to provide both traditional and modern craft skills and knowledge, necessary to produce fully rounded craftsmen. Some ideals were further consolidated

by the publication of *Brickwork: History, Technology and Practice* (two volumes) in 1994.

As Head of Trowel Trades at Bedford College of Higher Education in 1987-92, the author's pioneering work in broadening the curriculum for apprentice bricklayers sought to embrace many traditional skills, including gauged work. This was just one of many highly skilled areas of the craft selected to complement the essential modern elements demanded by the relevant City and Guilds syllabus. Unfortunately this period coincided with the demise of traditional time-served apprenticeships bound to a qualified bricklayer within a company, and the advent of short, competence-based modular training based on National Vocational Qualifications (NVQs) which could not facilitate such lofty ideals. This system of training is tailored solely to produce bricklayers with a narrow range of basic skills for the modern site environment and is combined with only an elementary theoretical and technical understanding of the principles underlying the trade.

Today, however, an increasing number of our historic buildings need repair and restoration, and bricklayers engaged in this type of work are very likely to come into contact with gauged brickwork. Unfortunately, the modern system of training does not cater for the additional craft knowledge and refined skills that he, or she, will need. It provides no avenue of any worthwhile depth to gain a full and meaningful understanding of gauged work, its historical development, and of the importance paid to it in the past.

1.2 Basis of Study

For over 30 years working as a craftsman bricklayer the author has taken every opportunity to learn more about the traditional practices of his once noble craft, many of which have long-disappeared from current knowledge and use. Gauged work is one such area. Seen as the consummate expression of the finest craftsman bricklayer, he was determined not only to master its skills and its underpinning knowledge, but also to research the subject in depth and answer its many questions. This has provided the basis by which the author has sought to discover the origins of gauged brickwork; the developments of the various tools, materials, craft practices, and their associated technological aspects; and to make this information widely known through his writing, lectures, master-classes, and consultancy services.

1.3 Aims and Objectives of Research

The overall aims of this work are to develop a deeper knowledge and understanding of the history and use of cut and rubbed brickwork from the medieval period, and the introduction of gauged brickwork in to England from the Netherlands in the seventeenth century; to evaluate, through practical work, the application and development of the historic cutting tools and equipment; and to determine the similarities and differences between performance and physical characteristics of historic and contemporary rubbing bricks, in order to inform modern production.

Dissemination of this research will promote understanding of the history and associated skills necessary to secure best practice methodologies, to safeguard the integrity of historic gauged brickwork. Furthermore, it will help to develop methods for the reintroduction of this craft into current training programmes and encourage its use on new building work.

The objectives of this research programme are:

1. To develop further knowledge and understanding relating to the history and use of gauged brickwork in England to enable promotion and dissemination of the assimilated information appropriately, to a wide audience of craft professionals.
2. To assess the development of specific tools, materials and craft practices to promote insight in to the importance that these played in the past. To examine how they might be reintroduced and where necessary adapted for current and future restoration of cut and rubbed and gauged brickwork, to help secure a more authentic aesthetic appearance.
3. To explore and gain a deeper knowledge and experience in the historic crafting aspects of gauged brickwork by designing, and building a niche masterpiece, using traditional techniques.
4. To evaluate the behavioural characteristics of traditional low fired rubbing bricks and, in particular, the development of the apparent protective case-hardening of the brick surface.
5. To determine production methods and weathering characteristics, enhancing understanding of the practical requirements for establishing a more widespread and contrasting modern day production of rubbing bricks, particularly for the conservation and restoration of historic buildings.

6. To assess the current supply and use of rubbing bricks in England, in order to inform current manufacturer's of any improvements that can be made in respect of the research undertaken at point 4.

1.4 Methodology

Given the interdisciplinary nature of this thesis the author has made considerable use of wider documentary sources as a historical underpinning to support this work. The methods of investigation used in this programme of research may be summarised as follows:

- (a) Literature search with collection and collation of relevant published data;
- (b) Site visits to significant historic brick buildings and structures to study the application of the use of cut and rubbed and gauged brickwork.
- (c) Discussion and meetings with key individuals and organisations;
- (d) Collection and collation of generic and specific information via questionnaires and structured interviews for use in the general text.
- (e) Collection of relevant brickearth and clay samples and associated materials used in modern day production of rubbing bricks.
- (f) Sampling and analysis of brickearths and clays used in the production of modern rubbing bricks.
- (g) Sampling and analysis of historic rubbing bricks used for cut and rubbed gauged brickwork to determine composition, manufacture, performance and mechanisms of deterioration and decay.
- (h) Experimental production and firing of rubbing bricks.
- (i) Having facsimile historical cutting tools made in order to re-learn their use and evaluate their effectiveness.
- (j) Preparation and execution of a scaled masterpiece of gauged brickwork as a means of investigating and demonstrating historical craft skills and techniques.
- (k) A list of associated activities conducted over the period of research can be found in Appendix 1.

2.0 HISTORICAL DEVELOPMENT AND USE OF GAUGED BRICKWORK IN ENGLAND

2.1 MEDIEVAL AND TUDOR BRICKWORK (1485-1603)

Following the departure of the Romans from Britain in AD 412, the brickmaking craft declined. During the Saxon and early Norman periods there was a movement towards permanence in the building of ecclesiastical and certain public buildings, and builders were quick to remove and re-use bricks from dilapidated Roman buildings. Brick was essentially utilised as a courseable element for quoins, dressings to doors and windows, and for vaults.

All Saints' Church in Brixworth (Northamptonshire), believed to date from the seventh century, is an early example of re-use, as is St Alban's Abbey tower in St Albans (*Verulamium*) (Hertfordshire). It became apparent to the Saxon builders that the supply of this very handy source of building material was going to run out and that new bricks would be needed.

The earliest known use of Post-Roman bricks in England is Little Coggeshall Abbey (Essex) c.1200-20, where new bricks were used for strengthening the flint Abbot's Lodging.

Of particular interest with regard to the brickwork is where Wight (1972, 25) explains:

... Most of the shaping was done by moulding, but sometimes - as in the hollow chamfer of the Chapel's East window (strictly, three lancets) - carving exposed the dark, less well-fired core of the bricks. The abbey bricks are vital to the buildings, providing windows, doors, jambs, quoins and vaulting ... The shaped bricks are singular for their date, unmatched by dressings of any elaboration till the mid fifteenth century.

This reference to carving the hollow chamfer, exposing the core (French 'coeur' meaning heart) of the brick, is of singular interest as it highlights an early English example of a 'cut and rubbed' moulded enrichment; a brick worked in a post-fired state.

Wight (1972, 26) concludes:

...The shapes include segmental bricks for round columns, lobed bricks for roll-mouldings, chamfered bricks and diamonds... At the Belgian Cistercian Abbey of Coxyde [Koksijde] are similar shaped bricks. The conclusion must be that Cistercians from the Continent, where brick was already established...carried out or at least supervised the brick-making here...

The Cistercian monks revived the use of brick as a principal building material in masonry in Flanders and the Netherlands during the late twelfth century. By the thirteenth century Flemish bricks were being exported to England. Certainly during the Middle Ages there was a tremendous increase in social and economic intercourse between eastern counties and ports of England and the Continent. Brickmaking and bricklaying were experiencing a powerful revival in Flanders, Holland and North Germany - areas short in stone and which were united in trade and industrial discourse through the founding of the powerful Hanseatic League in 1241.

Through ports at Norwich Lynn, Boston and Hull, the east of England forged trade links with the league, which were to have a profound and lasting effect on English brickmaking and bricklaying crafts and promote a major 'Netherlandish' influence on much of its architecture. The term 'Netherlandish', (Percival, 1989, 15) rather than Dutch, is considered a more appropriate word to include not just present-day Holland, but all 17 provinces of the original (pre-1579) Netherlands or low countries. Considerable quantities of Flemish bricks were shipped into England for important works, such as 202,500 bricks from Ypres (Ipers) in 1278 for the Tower of London (Wight, 1972, 26). As native brickmaking techniques and production capacity proved capable, this trade declined. The town of Kingston-Upon-Hull for example established a corporation brickyard in 1303 (Brooks, 1939, 156).

Brickmaking in the medieval and Tudor periods was essentially the same, although changes and developments inevitably took place; particularly as brickwork became highly desirable during the fifteenth century and a much higher standard of brickwork is seen. The bricks were made either from estuarine clay deposits on the banks of rivers, or shallow clay beds, often termed 'brickearth', or loam clay found especially in the Thames valley and eastern England.

Generally the clay was excavated in shallow digs close to or within the proposed site, but without pumps these could never be deep. Manual extraction was seasonal the clay being dug or 'won' before winter then stirred or turned to 'sour' before the last of the hard frosts to assist breaking down, and wrought (beaten) before spring. The 'tempered'

clay was then cast into a shallow pit to be trodden by people or oxen, ready for shaping or 'moulding'; stones or other foreign bodies were normally removed, where possible, at this stage.

Utilising a timber mould box or 'forme' was well established in the thirteenth century, casting the 'clot' (from the Dutch 'klutto' meaning lump) of 'green' or unfired clay into the box resting directly on the grass or straw-covered ground. Early bricks were large and often referred to as 'great' bricks, such as those at Waltham Abbey Gatehouse (Essex). These bricks are like the 'Klostermoppen' (Cloister bricks) of the Flemish Cistercian monastic sites at Ter Duinen in Koksijde (1214), at nearby Ten Bogaerte (1230), and at Ter Doest in Lisswege (1275), in present-day Belgium. These bricks measure 300-320 mm x 150-160 mm x 70-90 mm. They were rarely used in England after the late fourteenth century and by the mid-thirteenth century a size similar to our modern brick was increasingly common. Size was determined by the necessity to make it easy for the bricklayer to handle the brick, who prefers his trowel in one hand whilst laying, and is in relation to the span of the hand.

By the middle of the fifteenth century, a much higher standard of brickwork was introduced into England due to an influx of Flemish and Dutch craftsmen from around 1410 up to the 1480s. These began constructing features previously seen in the Low Countries and Germany. It became common for the brickmaker to work at a bench and throw the 'warp' (Old English 'wearpen' meaning to cast or throw) of clay into the timber mould, dampened with water. Excess clay was smoothed off the top of the box using a flat wooden stick or 'strike'.

Initially the bricks were laid flat on bed to develop a 'leather' skin for handling and gain sufficient hardness to later be stood, and stacked, on edge, without the brick settling down on itself and bloating. This drying period of 8-12 weeks was dependent on the prevailing weather.

The dried bricks were then 'fired' or burned in a kiln or 'kylne' (from Old English 'cylene' and Latin 'culina' meaning a burning place or kitchen) of a simple updraught type. Alternatively, and then most commonly, bricks were fired in a temporary kiln known as a 'clamp' ('clampe'); the terms can confuse in studying old documents as they are frequently interchangeable.

A clamp was a skilfully erected outer shell of previously burnt bricks or 'casings' (or 'burnovers'), placed around the green bricks (usually a whole season's production). These were close-stacked in tight rows with 'battered' ends to prevent collapse and with layers of fuel of wood faggots, heather, turf, and sometimes coal. The top was closed with a layer of burnovers. Were no burnovers available, then the outer shell of green bricks was plastered over with mud, similar to how a 'wicket' is bricked-up dry and plastered today (to seal a kiln entrance). The clamp, which would normally contain between 50,000 and 400,000 bricks, was then set alight from the 'fireholes' on the windward side.

Essentially an uncontrollable firing, the clamp was simply allowed to burn itself out over several weeks (Rivington, 1901, 97); a good deal depending on the size of the clamp and the strength and direction of the wind. Such a clamp was generally used for firing only standard bricks; special shapes (and roof tiles) needed to be fired in permanent kilns where open-stacking and a more controlled burning was possible. What is termed a 'box' could be created within a clamp, a small area about two-thirds up its height, to protect the bricks within it in order to produce rubbing quality bricks (providing, of course, that the raw material was suitable for such in the first place). It was also possible to burn some types of green-moulded specials, such as plinths, by interlocking them in such a manner as their arrangement provided a flat upper surface for stacking above them; but this was not a common practice. A kiln, depending on type and size, could vary in capacity, from 8,000 to 30,000 open-stacked bricks.

Bricks, during this period and for several centuries afterwards, were fired longer and at much lower temperatures than their modern counterparts, from 750°C to 950°C being a typical range, as opposed to 1,000°C+ common today. This was due to primitive firing conditions and the use of the above fuels, as opposed to more controlled conditions, and volatile modern fuels like coal, fuel-oil, and liquid petroleum gas (LPG) in common use today.

All of the above factors involved in traditional brick burning led to a wide range of fired bricks, which, upon emptying the kiln or disassembling the clamp, would be graded by skilled and knowledgeable brickmakers; who might also be bricklayers. Grading would be based upon degree of hardness, colour, and dimensional accuracy, with the selected bricks being set aside for specific uses within a proposed structure. Sound, well-burnt, and dimensionally stable bricks were reserved for face work. Over-burnt 'wasters', depending on distortion, could be used as hardcore or in the foundations.

'Flared' headers, produced adjacent to the fire channels, were frequently reserved for laying as headers to bond, producing decorative patterns in the brickwork on the principal elevations of a building. It is thought that this surface reaction was the combination of the high temperature (in excess of 900°C) and potash in that particular area of the clamp or kiln causing vitrification and discoloration of the brick face (Barksdale Maynard, 1999, 33).

Under-burnt bricks were termed 'semel', 'semeled', or 'samel', a combination of the Latin 'semi' meaning half, and Old English 'aelden' meaning to burn, hence 'half-burnt', as explained by Smith (1983, 5). Too soft and uneven of texture and colour, they would not be used for features where durability was required. Final brick colour was rarely an issue as colour washing or 'ockering' was a common practice on premier elevations, especially with high-status properties.

2.1.1 Hewen Bricks and Brickhewers

Bricks sufficiently fired to be sound, yet soft enough to be easily cut, carved and abraded to suit particular angles, shapes and enrichments were then either termed 'hewentile' (Wight, 1972, 66), or 'hewen bryke' (Thompson, 1960, 88). The term 'hewen' is derived from the word 'hew', meaning 'to cut' or 'cleave'. At Tattershall Castle (Lincolnshire) in 1438, 2,200 'de tegulis operatis vocatis hewentile' or 'worked bricks called hewentile' were supplied for the chimneys and windows of the (now lost) great stable (Smith, 1999, 3; citing Simpson, 1925, 26). At Fox's Tower, Farnham Castle (Surrey), 3,000 'hewen bryke' were supplied in 1473 as the multiple concave and convex mouldings surmounted by trefoil corbelling for the fake machicolations (Thompson, 1960, 88; Moore, 1991, 227).

That the majority of fifteenth and sixteenth century moulded brick enrichments were of 'roubed [rubbed] bryck' is readily apparent (Moore, 1991, 227):

... both from building-accounts and from the bricks themselves, the worked parts often revealing a core quite different from the fired face.

Firman (2003) takes this passage as an indication that the medieval and Tudor bricks that were 'roubed and hewn' are unlike the rubbing bricks, of uniform texture and colour throughout, used for the more refined gauged work of the seventeenth century onwards. Although it is possible to show some examples to support this view, especially

where a 'roubed' feature was to be stuccoed and appearance of the brick was of no importance, the majority of 'roubed and hewn' enrichments show consistent and uniform texture throughout. One need only study the cut and rubbed enrichments of England's fine mediaeval and Tudor brick buildings to see this quite clearly. It is unnecessarily difficult to cut and rub ornate mouldings on chimney stacks, tracery, labels, and voussoirs with bricks that reveal dark cores to the face, as such harder bricks (practical experience has conclusively demonstrated) do not respond favourably to cutting and rubbing.

This point was discussed with the late Nicholas Moore, who emphasised that the majority of mouldings from these centuries were not cast from the 'green' clay, but 'cut and roubed' to shape (Moore, 1994). The words '...the worked parts often revealing a core quite different from the fired face' simply indicate that one can visually determine that the face of the brick has been removed in the process of working, exposing to varying depths, textures and inclusions in its inner body. The photograph of a 'Finely finished' crocket at Wallington Hall (Norfolk) (c.1525), which Moore shows in his book, serves to illustrate that point precisely (Figure 2).

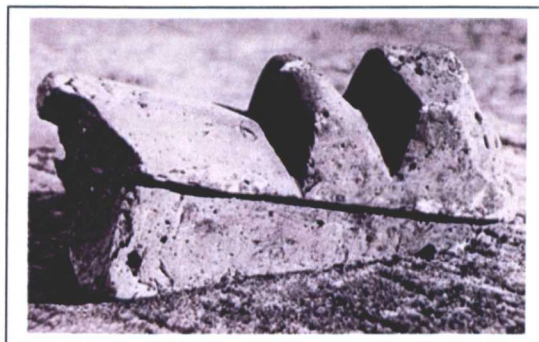


Figure 2 Finely finished crocketed finial brick, Wallington Hall (Norfolk) c.1525 (N.J. Moore).

It also supports his emphasis that these selected bricks were indeed capable of being cut and rubbed to a fine degree of accuracy, without detriment, and that those who executed this class of work were commonly called brekmasons (Moore, 1991, 233; citing Simpson, 1960, 60).

Some bricks used for medieval and Tudor cut and rubbed enrichments do reveal the presence of inclusions. This was inevitable with the cruder brickmaking techniques of these periods in comparison with the seventeenth century onwards, but rubbers of latter periods can also possess them, to varying degrees. Cutting open salvaged bricks used

for both cut and rubbed and later gauged enrichments from buildings of these periods has revealed their similarity in make-up and appearance (Figure 3).



Figure 3 *Sections of historic rubbing bricks from the sixteenth to the nineteenth century.

Practical tests using salvaged bricks from the early sixteenth century through to the nineteenth century have clearly revealed how all were easily cut using the mason's drag. It was noted that all freshly-cut surfaces showed similarly close-textured bodies, with or without inclusions, and when these were rubbed smooth, on the rubbing stone, it was achieved with minimum effort and produced sharp arrises on each brick. This, despite the obvious fact that they came from different regions of the country and were made from various types of clays or brickearths worked within a reasonable distance from their host building.

One can conclude this point by bearing in mind the overriding pragmatic approach contemporary bricklayers would have taken whilst selecting bricks for hewing and rubbing. By experience of the feel and appearance of the brick, they would know instinctively the one suitable for that purpose. They would not have known, nor cared about the geological age of the raw material, whether clay or brickearth, or the levels of internal silica. Their only care would have been that the brick was well-baked, could be

easily abraded, and worked to shape as they desired, to reflect positively on their craftsmanship within the built enrichment.

Skilled bricklayers executing the cutting and rubbing of bricks were termed 'hewers' ('hewyers'). Study of contemporary accounts shows this was an activity frequently programmed for the winter months, when bricklaying operations ceased due to concerns for frost damage with slow-setting lime mortars. According to Salzman, (1967, 45) the Westminster accounts of 1530 record:

...the hewyng of 50 tunnells (shafts) in bryke for chimnes and ventes for jaxys (jakes or latrines) which hath byn hewen this wynter by taske.

The accounts for Kirby Muxloe Castle (Leicestershire) for the week commencing Monday, 30th December 1482 (Hamilton-Thompson, 1920, 296) records:

Breekehewers - Peter Corbell. Maligoo, Dalle, Mylner, Ruddicowrt, Bruston, 5 days at 2s 6d = 12s 6d.

The majority of these craftsmen, being 'aliens', from Flanders, were internationally renowned masters in the art of post-fired working of bricks. They were much in demand in fifteenth-century England, particularly in the years from c.1410 to the 1480s. From that time Moore (1991, 216-17) states:

Brick emerged as a high-quality and decorative building material confidently handled by English designers and bricklayers... Imported details such as diapering and the spiral chimney were assimilated and developed... By about 1520 this impetus was largely exhausted, and the further development of brick decoration was mainly confined to East Anglia.

In essence Flemish, and later English bricklayers were viewing and utilising the selected bricks capable of being worked in a post-fired state, as building stones. In many early features of 'cut and rubbed' brickwork, such as window tracery, the element might be given a coat of render to mimic the stone it substituted, as at Gifford's Hall, Stoke-By-Nayland (Suffolk) of c.1490-1520, and Layer Marney Gatehouse (Essex), of 1520 (Figure 4).

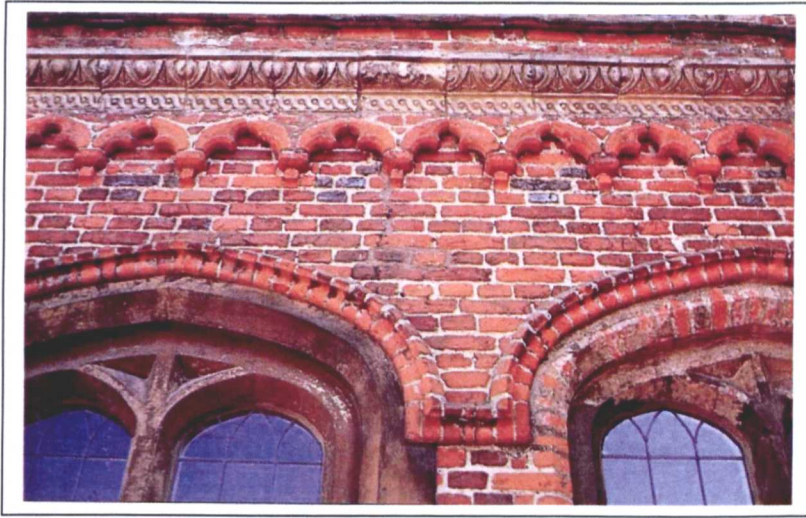


Figure 4 Layer Marney (Essex) gatehouse window detailing 1520.

The direct link with stone masonry at this time is very apparent. In Flanders a brick was, and still is, termed 'baksteen', which literally translated means 'baked stone'. In Calais at that time craftsmen termed 'maçons' (masons) worked and laid a material that was referred to as 'lapides vocati brykkes' or 'stones called bricks' (Moore, 1991, 233; citing King's Works I, 427, n.4).

2.1.2 The Flemish Influence

It is in the early fifteenth century that decorative English brickwork begins to truly assert itself. This change is accompanied by an early flowering of the craft of the bricklayer in England, as it slowly but surely emerged from behind the influence of the powerful stonemasons who held almost reverential control over the design and construction of medieval masonry.

The catalyst for this change was foreign and due in large measure to 'alien' brickmakers and bricklayers from the Low Countries, who brought a high level of craft skills and technical knowledge. This influence began to make its presence felt in the improved quality of bricks, more consistent in shape and quality, as well as in their application in terms of structural bonding, decorative patterning and ornamental articulation, which raised English brickwork to unprecedented levels of sophistication. It is particularly in the skills of working bricks, post-fired, for structural and ornamental brickwork that these advanced levels of craftsmanship and the Flemish influence are truly witnessed.

One can identify these as 'Flemynges' or 'Dochemen' (Dutchman or Deutchman) by their names. For example, 'Henry Sondergyltes, Brykeman', who was employed by the wardens of London Bridge in 1418; 'William Vesey', employed by the Crown in the 1430s (Wight, 1972, 22); and 'Bawdin Docheman', who was the 'brekemaker' at Tattershall Castle (Lincolnshire) in 1440. Hamilton-Thompson, (1920), reveals the numerous 'brekeleyers' and 'brekehewers' working at Kirby Muxloe Castle (Leicestershire) between 1480 and 1484 were Flemish (confirmed by historians in Flanders) with names like John Hornne, William Wysoo, William Taillour, Marc Maligoo, and Turkyn Horwynde. The last, Anthony Yzebronde, is also referred to elsewhere in the accounts as 'Anthony Docheman'; believed by historians in Flanders to be a Flemish, rather than German name (Beernaert, 1997).

The different terms of address of the craftsmen is of interest as the 'cleric' (clerk) recording them was likely to alter spelling in the records, anglicise their names, or write them phonetically. A good example is in the above accounts for Kirby Muxloe Castle, where 'Wysoo' is also found as 'Wyso' and even 'Wysall'. Another practice was to record the craftsman's native country, as in 'Anthony Docheman'. Sometimes the name defines their craft, so that we read (Moore, 1991, 231-33), of Cornelius and Brian Brekemason at Farnham Castle between 1475 and 1477, and of John Prentes and Thomas Leryng, clearly apprentice bricklayers at Kirby Muxloe in 1481. The name William Taillour, a Flemish hewer also at Kirby Muxloe Castle, is revealing, as 'Tailleur' is a Flemish mason's term for a skilled 'hand-dresser' or 'finisher' of stone or brick.

Moore (1991, 214-16) continues:

The introduction of high-quality work and foreign craftsmen appears to date from shortly after 1410, the earliest surviving building to combine them being the chapel tower at Stonor Park (Oxon) with its diapering and moulded brick corbelling, under construction by Michael Warrewyk and his Flemings in 1416-17....

...The extensive use of foreign detail on the finest buildings shows the domination of the industry by foreigners for a considerable period, tailing off only in the 1470s and 1480s.... Foreign brickmasons were still much in evidence in the building-accounts of Kirby Muxloe Castle (Leics.) 1481-4.

In spite of its turbulent history, Flanders prospered through the cloth industries, banking, and transit trade through ports like Brugge, Ghent, and Antwerp, and the enormous mercantile benefit of many Flemish towns being part of the rich and powerful Hanseatic League. This offered a close federation of influential cities in the Netherlands and

northern Germany, England and the Baltic region, formed in the thirteenth century to provide and protect mutual commercial interests.

The wealth of Flanders led to the erection of highly-decorated public and private buildings, financed by prosperous corporations, guilds, and merchants who were keen to display individual and civic wealth on their popular Gothic-styled facades.

There is little natural stone in Flanders, and that which exists is a soft limonite from the south Flemish hills and sandstone from Artesia. In abundance, however, were deep deposits of quality clay over much of the country from which bricks could be made. The inland clays producing a pale orange/red brick whilst the wider deposits of coastal polder clay, rich in calcium carbonate, produces a pale buff-coloured brick, not unlike stone in hue that yielded a smaller contrast between brick and mortar joint which was deemed perfect for masonry enrichment.

Gothic architecture, which was always fashionable in Flanders, especially 'Decorated', demanded great skill in the production of its enrichments of arches, tracery, columns, spiral staircases, and vaulting, so evident in the skilled work of European masons of the medieval period. This was particularly true of Flanders, where a unique, highly ornamental style developed called 'Flemish Renaissance'. The wealthy were able to finance well-patronised guilds of masons and bricklayers, which, in turn, became prestigious repositories of knowledge and craftsmanship. The prolific use of the pale-buff brick for enrichments, normally executed by masons in stone, inevitably led to the unique development and refinement of skills in the post-fired working and laying of bricks. Putting bricklayers and masons together led to a cross-fertilisation of knowledge and skills from which the former was the major beneficiary.

Closely-jointed masonry is symbolic of individual craft pride, demonstrating an accuracy of skill and resulting in stronger construction, and appears to reflect the sense of national pride and standards. When the Roman Empire was at its zenith of power and state discipline, the quality of its masonry was extremely accurate with refined joints between bricks or stones. As the Empire declined, so did the standards of its masonry and joints widened significantly. This was also true of Flanders.

Vershelde (1871, 5-21) provides the 51 detailed articles for the Brugge Guild of Bricklayers for the first half of the sixteenth century. It reveals that only fifteen-year-old middle-class boys, whose parents could finance their training over a four-year

apprenticeship period, could be accepted. At the end of their apprenticeship they would have to produce their 'proefstukken' or masterpiece in front of two competent masters. The rules laid down the choice of three masterpieces - two difficult ornate styles of doorway or an ornate window, in the construction of which the apprentices would have to demonstrate skills in 'bewerkte baksteen' ('worked-on bricks') or as termed in England, 'cut and rubbed brickwork'. The articles state that although a mason had to draw the design for his masterpiece, it was not compulsory for a bricklayer; yet it acknowledges that, the best bricklayers were also good draughtsmen.

Clearly, by studying Flemish brickwork, and particularly the practice of treating bricks as stones for enrichments, one can see cutting, and rubbing, to have become a ubiquitous practice with signs of post-fired working very evident on the faces of the bricks. This was achieved by way of 'axing', and the use of either plain or combed-head chisels. The popular calcareous buff-coloured Flemish bricks would be slightly harder than, for example, the English orange/red bricks of the same period, so requiring more robust tools and techniques to work the face.

Flemish bricklayers at the workshop of Master Builder Arthur Vandendorpe in Brugge, continue to set out and cut brick mouldings in the traditional manner, such as for the restoration of Gothic tracery or 'maaswerk'. Once the brick has been cut down to the basic size, the required shape is obtained from full-size templets (as bricklayers traditionally spell templates) prepared as individual boxes, into which the brick is placed, scribed, and removed for cutting and replaced afterwards to check accuracy (Figure 5). Today, disc-cutters are used but formerly this would be done with a handsaw, brick axe, hammer and chisel, or whatever cutting tool(s) suited the desired shape.



Figure 5 Flemish templet box for scribing and checking a cut-moulded brick.

Demonstrating his dressing skill as a 'tailleur' (Figure 6) or 'finisher', a foreman bricklayer places a brick on-edge at an oblique angle in a bench-mounted timber box to hold it securely. With a mason's mallet and booster, he 'walks' the booster across the brick surface as he rhythmically taps it with the mallet to produce a series of parallel stripes across the brick face, like a 'tooled or battled ashlar' dressing that is seen on mason's stonework in England. This finish is known in Flemish as 'frijnen' (freynen), meaning driven or striped. In some respects, these parallel lines are faintly reminiscent of the herringbone tooling on the eleventh-century bricks in Sienna, described in section 1.1 above.



Figure 6 Flemish 'Tailleur' producing a 'frijnen' finish to a cut-moulded brick.

Observing late sixteenth-century Flemish 'bewerkte bakstenen', most laid with tight joints so that it can almost be considered as early gauged brickwork, neat *in situ* finishing is present, similar to how a mason would 'drag-finish' a stone in dressing. This, it is concluded, could not have been 'Frijnen', as it is not suited to finishing *in situ* brickwork set in slow-setting lime mortar. The clue to the method was in how the Flemish referred to this finish, in English, as 'planing'. The parallel striations, bridging joints, run plumb to a vertical moulding or follow the curve of an arch, being produced by a tool called a 'steenschaaf', (stoneplane). This is a wooden tool of various lengths and shapes with integral handles, and having flat, convex, or concave shaped (smooth or combed) blades set into slots all along its underside, parallel or angled against the direction of 'push'. In England, this tool is called a 'French scraper' or 'French plane', only used on soft stones; and according to English masons it was never popular. The steenschaaf was used by the bricklayer/mason for running along the stone or brickwork

dressing *in situ*, during the finishing process, in a similar manner to how a carpenter planes his wood, to both line up the work and clean the faces (Figure 7).

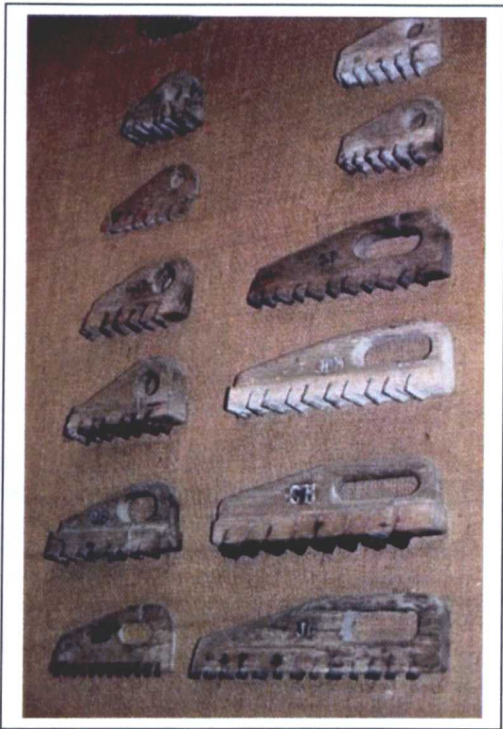
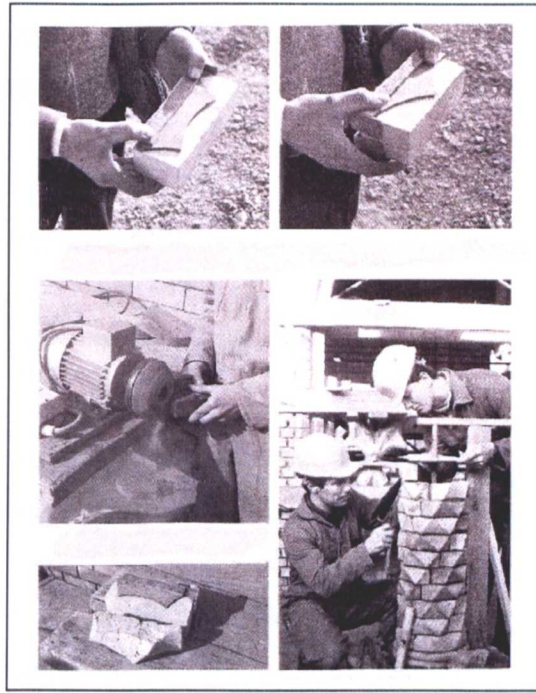


Figure 7 Flemish 'Steenschaafs'.

In the Vrij Technisch Instituut (VTI) te Brugge, advanced craft students are given high-quality training in restoration skills necessary to maintain the architectural heritage of Brugges and the surrounding area of Flanders. Here, amongst the many Flemish methods of working bricks post-fired, it is particularly interesting to observe students using mechanical carborundum grinding stones to abrade shapes into the faces of bricks, where possible, for enriched mouldings. Upper and lower bed profiles are scribed from 'clip moulds' obtained from the full-size working drawing, such as for a spiralled brick 'topstuk' (finial). The two opposing patterns are united at the middle during the rubbing process by manipulating the brick face against the spinning abrasive to the desired profile (Figure 8). This adds weight to the long-held belief that the large circular grindstone, used in the cutting shed for hewers to sharpen their tools, was also utilised where possible to rub part, or all, of a moulding on the bricks.



*Figure 8 *Flemish bricklayers cutting and rubbing moulded bricks for a 'topstuk' (Monumenten & Landschappen, Nederlands).*

Historians and archivists with the Flemish heritage authority, Monumentenzorg (Beernaert, 1997) do not think that their great masters, or indeed even their first-class Flemish bricklayers, ever came to England to work in the fifteenth century. This is because they were in very great demand at home, and extremely well paid and secure in their employment. It is the opinion of modern Flemish historians (Beernaert, 1997) that only 'journeymen' bricklayers, still skilled in 'bewerkte bakstenen' (but not top masters), would have come to work in England. This is possibly why so much Flemish brickwork of this period is a long way ahead, in terms of style, finishing and overall quality, to that being achieved in England at that time.

In studying post-fired brickwork across much of Flanders, there is a singular revealing aspect to almost all of the historic Flemish 'bewerkte baksteen', and particularly where the quality is virtually gauged brickwork. The overall bonding pattern is frequently treated more like ashlar stonework, rather than the disciplined and rule-abiding manner normally associated with good brickwork. This is almost certainly an indication of stonemasons being involved in its construction.

The last quarter of the sixteenth century, despite all the innovative refinements of its brickwork, was the end of the 'Golden Period' for Flanders. The country was under the rule of King Phillip II of Spain (1527-93), determined to crush Protestantism in the Low

Countries as the effects of the Reformation spread. The medieval cloth trade declined rapidly, resulting in calamitous and long-lasting social and economic consequences for the country. Architecturally, Flanders became trapped in the mannerism it helped to create.

As Kuyper (1980, 60) emphasises:

Politically, Classicism meant the assertion of independence... but after the surrender of the Hapsburg monarchy, Flanders could not contribute to classicism.

Master craftsmen were not just very skilled, but also literate, numerate, and highly respected freemen citizens of their guilds, enjoying high status and repute. The liberation and freedom to explore new possibilities that the Protestant faith appeared to offer attracted many, though not all, from Catholic Flanders. Whilst some migrated and settled in Protestant England, in such places as Sandwich (Kent), the majority of craftsmen and intellectuals simply moved north into the neighbouring Protestant provinces of the Netherlands, such as North and South Holland. This was a further economic blow to the confidence of Flanders, though an immense cultural and mercantile benefit to their new homeland and neighbour about to enter her own 'Golden Period'.

Whilst the Flemish influence on gauged brickwork has relevance to this work, it is not prudent to go into it in any greater detail. For further information see Lynch, (1998; 1999).

2.1.3 Bricklayers and Brickmasons

During this late medieval period there was no distinction made between structure and decoration on masonry and authorship of the buildings was deemed unimportant. Although designing required a level of intellect and its decoration was seen as a subsidiary skill, designs were usually the collaborative effort of the patron, master mason and builder, though only the patron was truly recognised.

In England, during the fifteenth century, there was a period when stonework became unfashionable and numerous masons readily moved from stone to brickwork. That in fifteenth-century England some bricklayers worked also as masons is undisputed, being termed collectively 'Breekmasons' (Moore, 1991, 232-33):

Building accounts including both brick and stone construction often show the interchangeability of brick and stone layers... at Kirby Muxloe, Leicestershire some of the most skilled bricklayers were paid in May-July 1482 as 'roughmasons'.

Harvey (1984, 73-74) indicates that at Kirby Muxloe Castle the master mason placed in charge of the bricklaying, and small elements of stonework, was John Cowper, who trained as a stonemason at Eton College. Robert Newby was the master bricklayer and master mason at Lincoln Cathedral in the 1520s and Christopher Dickinson was master mason at Windsor Castle and Nonsuch Palace, yet the Nonsuch accounts record his role there as a Master Bricklayer (Harvey, 1984, 213). Piers Conway, stonemason (Conway, 2002) states:

It is my belief that when the craft of 'cut and rubbed' brickwork came to this country, the lack of craftsmen in this field would have provided an opportunity for out of work stonemasons to take up the mantle and apply their skills to the new fashion. This would have been viewed at that time as perfectly natural.

Ordinary bricklayers would have been skilled only in 'setting' or laying standard bricks to bond, hence, probably, the not infrequent use of the term 'brickmasons' (with various spellings) in contemporary documents (Moore, 1991, 228-33; citing Simpson, 1960, 60).

2.1.4 Post-fired Cutting or Green Moulded

All the time and expense for 'cutting and rubbing' bricks may seem strange to many observers today. Why not make a mould to the desired shape and cast the shape before firing when so many repeats would be needed? There are several answers to this:

- The slight warping and twisting of the varying brickearth/clays in firing would be a problem for enrichments, especially where precision was vital (not so much though for those bricks hidden by stucco).
- The lack of skill of brickmakers in making sophisticated timber mould boxes to cast the clay in and mould the special shape before firing.
- The problem of moulding complex shapes that possess deep undercutting made their removal from the timber mould box, fixed with removable 'negatives', virtually impossible.
- The prolific use of 'clamps' to fire bricks, where the close-stacking arrangement of standard bricks and lack of firing control did not suit the

production of 'specials', which, like roofing tiles, generally needed to be kiln-fired.

- The inherent quality of some brickearth/clays, when low-fired, to be easily cut to shape and abraded to a precise profile and smooth finish.
- The employment of masons and the continuing development of some of the highly-skilled brickmasons/bricklayers as 'hewers' able to expertly 'cut and rub' bricks quickly and accurately to the desired shape.

2.1.5 Cutting Mouldings from 'Green' Clay

There is evidence on some enrichments from the second quarter of the fifteenth century that, occasionally, mouldings were also cut from the 'green' (before firing) clay brick whilst semi-dry (Beswick, 2001, 24):

The bricks for most buildings were made on the spot by an itinerant brickmaker employed for the purpose. Often he served as the bricklayer as well.

This important latter point is emphasised by Moore (1991, 233):

Some bricklayers also made bricks. Antony Yzebronde, apprentice bricklayer at Kirby Muxloe, spent more time at the kiln than with his master....At Camber Castle in 1539 Gilbert Drynkerst was successively head bricklayer at 7d. a day, brickmaker at 8d....

Peter Minter, proprietor of the Bulmer Brick & Tile Company in Suffolk and respected authority on traditional brickmaking and historic bricks suggests (Minter, 1997) that:

...this method could well have been carried out by the brickmaker under the guidance of the brick mason speeding production. ... the identification of cut post-fired bricks as opposed to cut and green bricks, is as follows:

Cut after firing. The material, even at low-fired state, is hard and abrasive, and requires the use of saw, scutch, rasp or any other tool capable of cutting down and rubbing to a finish. Marking out done even with a sharp instrument would only leave a shallow scratch in the surface of the brick, whilst a rasp tends to leave striations on the face. Poorly prepared clay and other inclusions become exposed when cutting into the core of the brick; these are then visible or in some cases fall out of the body of the brick during its lifetime.

Cut green. Providing the clay is some three parts dry, it is possible to cut with a knife or chisel in the way a carpenter would work wood. The marking out is bolder due to the softness of the material and a more permanent mark is left, often becoming more pronounced due to weathering. When cutting semi-dry clay, the knife will tend to smear or smooth the surface of the cut, so giving a somewhat polished effect. Nodules of harder clay are cut, leaving evidence of their presence, but burnt into the brick once it is fired. Timing of the cutting varied, giving rise to a different size to the finished brick due to the amounts of shrinkage still to be experienced. This can be up to 8-10%. Again, a careful check, particularly of the marking out marks, will confirm the state of wetness of the brick.

These final remarks highlight the then particular problem of cutting mouldings with green clay. On-going drying and shrinkage of the clay would mean that, unless the hewer cut all the mouldings within a day or two of each other, there would be noticeable differences in the subsequent fired mouldings; as well as accompanying minor distortion in firing. Also, in the longer term, the resultant thin and smooth/polished surface of the green-cut face has a tendency, with weathering, to peel away, leaving a rough core exposed, aesthetically disfiguring and opening the brick to decay; something that does not happen with post-fired cut work.

The rather intriguing ornate brick gateway in the garden of Stutton Hall (Suffolk) (c.1553) is illustrated in two photographic plates by Lloyd (1925, 312-13). The garden-side elevation is executed, from the cornice level down, with Renaissance detailing (as opposed to the Gothic parts) rendered to resemble stone. This stucco was carefully removed about 30 years ago exposing the Tudor brickwork, providing a valuable insight into how the above-mentioned methods (cut before or after firing) could be employed together on a decorative element (Figure 9).



Figure 9 Gateway to the garden of Stutton Hall (Suffolk), c.1553.

Study of the moulding to the voussoirs (not cut to radiate with the standard size mortar joints thus being 'v - shaped') of the semi-circular arch reveals how their ovolo profile

was green-cut. The tell-tale signs of slight dragging of the surface inclusions and the smooth/polished appearance, with accompanying shrinkage cracks, that subsequently occurred during the remaining period of drying prior to firing are clearly evident. Many of these voussoirs also exhibit the characteristic signs of veneer delamination, as described above (Figure 10).

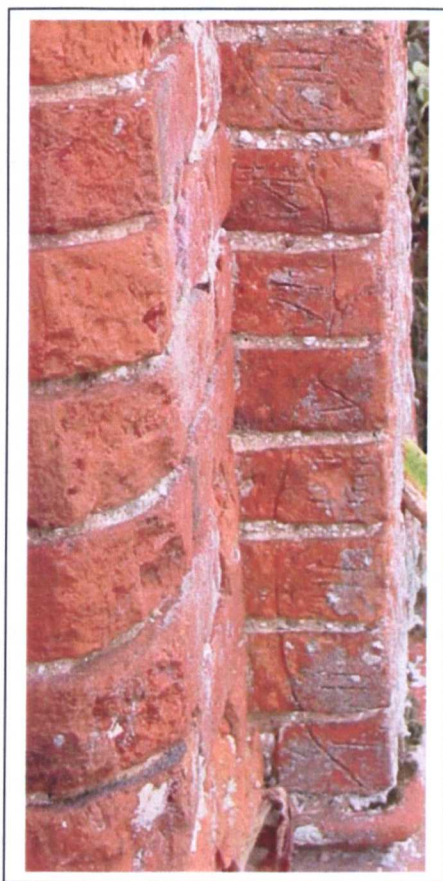


*Figure 10 *Green-cut moulded voussoirs to the garden gateway, Stutton Hall (Suffolk), c. 1553.*

The double-engaged fluted pilasters with entasis on either side of the arch are detailed with base and neck moulds, capitals, corona and drip, and a terminal cornice, again set with standard-sized joints. All have been both green or post-fired cut and rubbed to shape, or possibly a combination of both techniques. Clearly, the more intricate mouldings display the classic signs of cut and abraded inclusions. The pilasters are most revealing, as the evidence indicates that they were laid out to bond position and then cut to their correct entasis at the green-clay stage. The un-rubbed ends of each respective brick to the sides of the pilasters still have the original scribed numbers for the correct order of erection, Roman numerals were used because it is easier to scribe straight rather than curved lines and less likely to be misunderstood. These are consistent with having been executed on the green bricks.

Of particular interest is the use of, what is termed in the Netherlands, an 'accolade' (Figure 11), being scroll-shaped, green-scribed lines on the side of the pilaster bricks to ensure they were properly sequenced to maintain the correct entasis as laid to the capital. The flutings, however, were cut and rubbed post-fired, as again one can clearly determine the cut and abraded inclusions. It is likely, though, that the positions of the flutings were scribed in outline on to the pilasters when they were laid out for cutting the

entasis at the green-clay stage. These were then re-checked, scribed, and cut in properly after firing; hence also the need for the 'accolade' to help align the flutings.



*Figure 11 *A green-scribed 'accolade' to help align a fluted pilaster on the garden gateway, Stutton Hall (Suffolk), c. 1553 (Jeff Baker).*

One can see, therefore, that although there was some cutting of mouldings at the green clay stage, there were greater advantages to cutting and rubbing them on to post-fired bricks to gain consistency in both size and shape.

2.1.6 Cutting Tools and Techniques

Hand tools may be categorised (Salaman, 1975, 605) as:

...those used by craftsmen in the performance of a manual operation, such as chopping, chiselling, sawing, filing or forging, that directly shapes a piece of material into a desired form.

... The common denomination of these tools is removal of material from a workpiece, usually by some form of cutting. The presence of a cutting-edge is therefore characteristic of most tools...

Close examination of many shaped and enriched bricks on fifteenth-and-sixteenth century buildings clearly reveals that the majority had been worked post-fired, as described above. Studying contemporary documentary evidence can substantiate this, which frequently records the tools used, as described above and indicated by Moore (1991, 227):

Tools for this must have been among the dozens of axes, chisels and 'other' or 'small' tools frequently sharpened by the Smith. In 1533-4 a brick-axe at 8d. and three stone hammers at 6d. each were bought for the bricklayers at Windsor Castle. At Stonor Park there is corbelling with chamfers and simple mouldings on the chapel tower, cut with the aid of four hand-saws provided in 1416-17.

Hewers would undoubtedly have availed themselves of cutting and finishing tools used by masons that would be suitable for bricks. These would be as used on soft calcareous stones, which was certainly the case with the Flemish craftsmen.

It is important, however, to realise these highly skilled yet pragmatic craftsmen, having selected tools from the mason's wide range, would then adapt the tools and techniques necessary to suit brick.

A generally larger mass of stone anchored on the floor, or banker, leaves the mason's hands free to use his tools on a rigidly fixed material. This would not be true of a small, lightweight post-fired brick to be cut and worked to shape. The hewer would be forced to either hold the brick down on the banker or rest it against something to prevent it sliding whilst cutting and abrading with the selected tools in his free hand. Alternatively, he might choose to rigidly secure the brick on the banker to leave both hands free.

The former method would have been the easiest and the most popular method for the hewer to cut and rub basic shapes and mouldings the latter being sensible practice for the production of the more intricate cutting and abrading of detailed mouldings, requiring two hands to guide the tools. These methods are not documented (common every-day sights rarely were), but could have been as simple as a timber batten (or 'stop') nailed to the banker for the bricks to rest against. Alternatively, a 'sand-tray', which, as the name suggests, is a tray part-filled with sand for the brick to be bedded into, would serve to resist most movement.

Peter Hill, consultant stonemason, provides another possible method, which takes the form of a rudimentary clamp devised by resting a suitable-sized batten fixed with a twisted cord passed to a bar below through a slot on the banker (Hill, 2000) (Figure 12).

The upper batten rests upon the brick to be worked and the other, opposite, serving as a support. As the lower torsion bar is turned, the tourniquet effect clamps the brick tight.

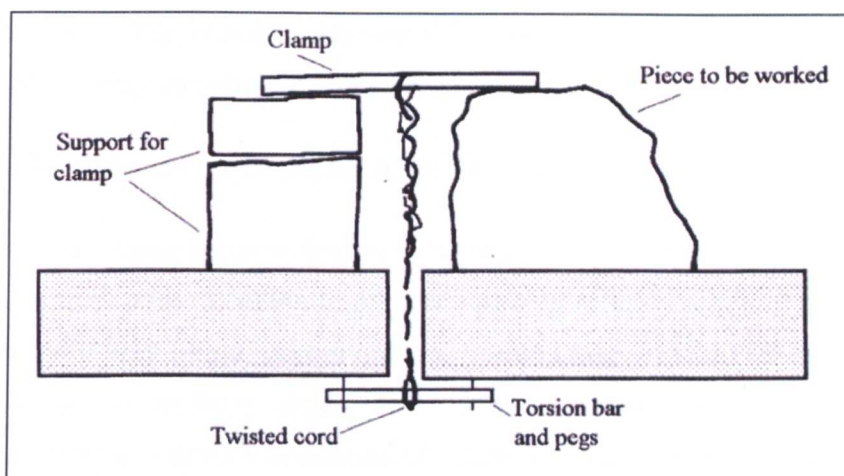


Figure 12 Rudimentary clamp to secure small stones or bricks whilst dressing them (Peter Hill).

Yet another method that could have been adopted, as suggested by stonemason Piers Conway, was (Conway, 2002):

Fixing down a small brick could have been achieved with small 'dabs' of Plaster of Paris to the base of it to hold it to the banker prior to being carved.

All of these craft practices are upheld by the author as sound and pragmatic alternatives to facilitate working individual rubbing bricks.

Chisels

Chisels, in a variety of sizes, worked with a hammer or mallet, are among the most common tools used by the mason for cutting and shaping stone. In tests carried out by Peter Hill, using his own mason's tools on rubbing bricks to produce some cut mouldings in the manner of a mason, concluded (Hill, 2001):

It was clear from our experience that working with masonry tools such as the mallet and chisel is not satisfactory for removing large amounts of material. This is owing to the nature of the material, which seems less cohesive than stone. There was a strong tendency for the brick to 'pluck' when removing more than two or three millimetres at once.

Hand-saws

The small hand-saws mentioned above would have been similar to what Moxon (1703, 245) displayed in *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work* and described as:

A saw made of Tinn, to saw the bricks where they cut

Later, this type of saw became known to bricklayers as a 'grub-saw', used for marking around a templet prior to cutting to prevent spalling, or splintering, of the brick face around the new arris (edge) during cutting. It would also be used for cutting away, to the established setting out lines, large parts of unwanted brick following the long-established masonry cutting sequence of 'chamfers, fillets, hollows and humps'. The saw was utilised to make a series of cuts down to line, directly into the fillets and hollows to facilitate chiselling-out or 'axing'. This saw is very similar to the mason's 'drag' and to a lesser degree the 'cock's comb'. In both the teeth would have no 'set' and the latter was used for cleaning-out small hollows, detailing, and the intersections of some mouldings.

Drags

With specific regard to the use of a mason's drag for finishing a moulding Peter Hill (2001) made the following observations, based on the trials noted above:

The use of drags was clearly most satisfactory for removing up to 5-6 mm of material down to the finished surface. This was very quick and easy, and when used with care few if any marks were left on the surface. You get better control with one hand above and one below and that if you lay the drag almost flat the effect is much reduced. Keep working them in two directions or more, up at 45° to one side, slide it back, and up at 45° to the other side; it is a sort of figure-of-eight movement. If you don't go in two directions you will soon wear a hollow.

Brick Axe

The brick axe was clearly a very popular cutting tool amongst medieval and Tudor hewers and remained in use, with some changes in style and skill in its use, until well into the nineteenth century. The brick axe of this period, forged from a length of iron, resembles a double-bladed bolster with two wide blades at opposing ends with average dimensions of 5 ins (127 mm) in blade width. It is typically 12 ins (306 mm) in overall axe length, a round central grip of 4½ ins (115 mm) and weighs about 3 lbs (1.36 kg) (Figure 13) It is most likely, however, that brick axes would have been made to suit

individual craftsmen. The brick axe appears to have come into England with the craftsmen from the Low-Countries where it was termed a 'bikijzer' (brick iron/ blade) (Janse, 1998, 41). The brick axe was used for roughing-out or chopping away waste brick and/or working a surface flat. Also, where necessary, it might be used for finishing, or dressing, the brick surface and in this respect the tool resembles a form of chisel as much an axe.



Figure 13 Selection of iron brick axes to the Moxon specification.

In his work on the significance of cut and rubbed brickwork on Tudor chimneys, Smith (1999, 3-8) describes evidence of post-fired working using a brick axe. Gleaned from studying a salvaged original cut-moulded brick from an ornate chimney of a demolished Tudor Palace at Bridewell, London, (1515-23), now in the Museum of London, he comments:

The brick itself... shows tool marks which 'indicate that the brick was shaped by cutting rather than moulding'. These tool marks are somewhat coarse in their execution... suggesting the use of a brick-axe.... and from the dimensions that the shaped brick was cut from one of the standard bricks used for the palace....

Even more significant are the scribe-lines on both bedfaces of the Bridewell brick. The cutting or carving of brick chimneys could have been done either by shaping the individual units and then laying them or by carving them *in situ*. It is likely, in fact, that a combination of both techniques was used....

Reference to the possibility of carving the mouldings *in situ* on a Tudor chimney stack is sometimes touched on by other commentators (Wight, 1992, 100). It is suggested it could never have occurred. The slow hardening and relatively weak set of a lime mortar, binding many small and lightweight bricks into tall slender shafts, make it both impractical and dangerous. Also, there would be no practical sense in carving out the detail high up on a building when it all could be executed in the comfort of a workshop, dry-assembled, and then taken up the scaffold in the order of laying. What was

probably observed and misunderstood in the past was the practice of 'humouring'; that is, adjusting lines and angles by abrading in the finishing phase to ensure all constructional elements swept neatly into one another.

With respect to this Smith (1999, 6) concludes:

As noted, the tooling on the Bridewell brick is somewhat coarse.... It is not at all unlikely, therefore, that such bricks were given a finer finish, probably by rubbing with another brick or with a suitable stone.

Some cut and rubbed chimneys would have been finished with a colour wash as Woodforde (1976, 48) records that at Collyweston, Lincolnshire, in 1504, a deficiency in redness was helped out with:

vijlb [7pounds] of red ocker [ochre] with 1oz. [Ounce] of the Glovers lether, vjd [7 pence]. Item to John Bradley wiff for xiiij [14] gallons of small ale for the said cheney of bryk, vjd [6 pence].

Study of a number of cut and rubbed ashlar and moulded enrichments on several English medieval and Tudor brick buildings, has revealed a common 'finishing' axing technique being used by the hewers to varying standards of workmanship. This would sometimes make an allowance for the viewing distance (i.e. if the feature was high up, it might be roughly axed, yet would appear neat and to profile to the viewer at ground level). For example, bricks axed for quoins and splayed reveals, yet not rubbed smooth, reveal the hewers always dress the faces of the brick diagonally; generally from top left to bottom right in a series of parallel strokes. These angles vary, however, presumably due to individual craftsmanship, from 45° and 60° (approximately) in a manner similar to what masons term 'boasted ashlar' work. This practice was also repeated for simple mouldings, such as 'cants' used for reveals or voussoirs in arches, where clearly the diagonal axing marks provide evidence of the brick being dressed first before being cut to the wedge-shape of the arch voussoir; a two-or-even three-stage cutting process.

With more ornate mouldings, possessing concave or convex curves, the techniques were modified. If practical to use the brick axe, then it was worked so as to cut parallel to the run of the moulding, as in the Bridewell chimney brick, where the axe strokes follow the length of the roll mouldings (Figure 14). Where access with the axe was possible, though not to chop with it, it was then used in a 'paring' manner similar to a carpenter's use of a wood chisel to gouge out the desired profile.

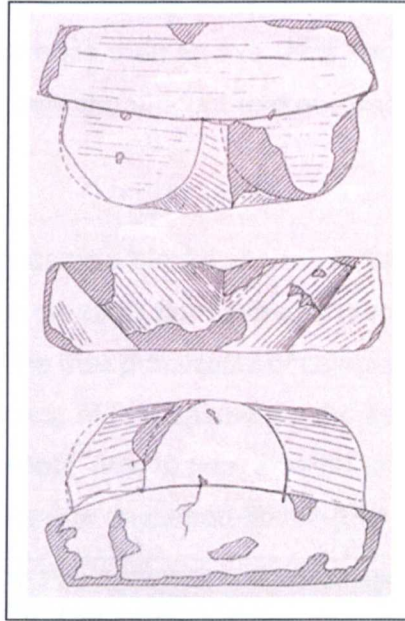


Figure 14 Drawing of the early Tudor chimney brick from Bridewell Palace, London, 1515-23 (T.P. Smith).

The question should be asked as to why the hewers work the plain face of a medieval or Tudor brick in the first place, when only needed for a quoin stretcher or the cut-splayed header? The answer appears to lie in how bricks of this period were moulded, as described above. The excessive moisture content in the 'slop-moulding' process meant once the green brick was de-moulded it could settle downwards into its bed, giving a slightly swollen or 'bloated' face. This, the hewer would have sought to dress to provide flat faces approximately square to each other.

It is further noticeable that most hewn bricks tend towards orange in colour, simply because these would have been the selected baked bricks, sound, yet possessing an easily worked body; ideal for cutting, carving, and abrading.

How the brick axe developed is lost in the passage of unrecorded history, yet it is possible to put forward a plausible theory based on practical experience of working post-fired brickwork and of re-examining craft tools and techniques no longer used but historically associated with such work. As stated above, masons/hewers would have adapted their tools for suitability of purpose and the varying types of wooden-handled stone axes in use during these periods would have been unwieldy. They generally require two hands to use them and would have produced too heavy an impact on the brick. 'Hafting' does, however endow a tool with better control.

A bricklayer, whether cutting or shaping, likes the blade of his tool parallel to his body, so that it works more like an adze than an axe. This enables him to exercise better visual and physical control over the amount and accuracy of the material being hewn from the brick.

A series of tests carried out using a blacksmith-made facsimile of a fifteenth-century brick axe provided evidence on axing both ashlar and moulded enrichments. This work was undertaken to assess the true practicality of using a brick axe, in order to help develop a better understanding of the reasons for the development of this unique, and once highly-prized, hewer's tool. Also to gain a better understanding of why the bricks were being worked in the manner described above (Figures 15 and 16).



Figure 15 Gerard Lynch axing a moulded brick for a Hampton Court Palace chimney.



Figure 16 The finished axed moulding against its templets with the brick axe.

Using one hand to holding the brick was, and remains the preferred craft technique for cutting and shaping, so there would be a desire to work with a small cutting tool that would facilitate this practice. It is quite reasonable to imagine the craftsman ignoring the hammer, yet picking up a wide-bladed 'bolster' by claspings the shaft, so the blade emerges beneath the hand, and proceed to chip away at the brick, removing waste and developing the desired profile and finish.

Testing this process revealed that, although it works to some degree, it is not practical, because bolsters are percussive tools to be struck by a hammer. It also proves uncomfortable, poorly balanced, and requires much effort to make up for the lack of tool-weight over the cutting-edge; negative factors that would have been apparent to the medieval craftsmen. The development of a sharp double-bladed bolster, thus creating the brick axe, is both a logical and practical outcome of such a situation.

Tests on the use of the brick axe also invited comment from craftsmen bricklayers and stonemasons, all unfamiliar with the tool. It was highly praised by all parties; somewhat surprised and impressed by how it performed. Hill (2001) stated that the brick axe was:

... awkward to use at first, but with a little practice became easier. In particular, working in an arc so as to use only about half the blade width at once proved very satisfactory, and removed material more accurately and more easily. There was also much less tendency to pluck.

The opinion, therefore, was of a well-balanced and comfortable tool with good control and very effective in executing tasks for which it was designed. The double-blade, it was agreed, served several purposes. Firstly, as described above, it gives balance either side of the handgrip. Secondly, forging two blades saves metal for a given weight of material. Thirdly, it gives weight above the lower cutting-edge and behind the blow being delivered. The final advantage is the benefit of an extra blade, sharp and ready for immediate use as the other blade dulls, requiring the attention of the blacksmith only half as often.

This latter point is of importance, as even though the bricks selected for cut and rubbed work were relatively soft, they still caused the edge of the brick axe to dull rapidly. This accounts for the large number of brick axes being used by the hewers and frequently sharpened by the blacksmiths. Contemporary accounts for Kirby Muxloe Castle (Leicestershire), reveal sharpening every two or three weeks in the winter of 1482, (Hamilton-Thompson, 1920, 293-94):

Monday 18 November...

Smyth, ...For sharpyng 10 dosen axes with Chesell and other
Tooles, at 2d [a dosen]...20d

Monday 9 Dec[ember]

Smyth, ...for sharpening 12 dosen axes with Chesells and other
Tooles, at 2d...2s 0d.

The sharpening of brick-axe blades and other cutting tools was not just a simple matter of grinding on a grindstone, as at York in 1499 where Salzman (1967, 337), says the blacksmith was paid:

Pro les gryndyng les axes et tules", or for the grinding of axes and tools.

This type of sharpening would be executed on what Salzman says was "a great round stone...." Called a 'gressour' or a 'gryndelston'.

It was generally accepted that it took one blacksmith to keep three masons continually provided with tool care, including re-working the edges of cutting tools, by what was then termed 'bateracione', or 'battering'. (Salzman, 1967, 337) quotes a payment:

...to Katherine the smith-wife for steeling and battering of the masons tools.

Axing Technique in Practice

Why hewers axed their bricks in the manner they did becomes apparent when testing the brick axe in use. On a brick face the diagonal axing strokes would appear to be based on achieving flat faces, square to one another in the simplest swiftest and most effective manner. In preparing stone, a mason looks first to work the surface flat, the accuracy of which is vital so that the other planes and angles related to it will not be thrown out. Due to the normally large size of stone this typically involves using a mallet and chisel to work down, about 25 mm, two flat draughts, or drafts, at opposite sides. Once formed and checked, the mason will then work across the face of the stone, one side to the other, using the original draughts as guides. The surface is then cleaned with the boaster and drag and the flat surface checked by using a straightedge diagonally from corner to corner.

Hewers working a narrow face on a brick (in comparison to stone) simply followed an older stonemason practice from the eleventh and twelfth centuries when working with a stone-axe, evident in studying the stonework of this period (Colvin, 1982, 333-34):

With their unmistakable axe-tooling, diagonal on flat surfaces...

They worked the face of the brick down using the brick axe between two adjacent diagonal arrises (edges), flattening, checking, and presenting a textured or 'axed' finish, all in the one action. It is important to remember that with the normally large width of the bed joints on brickwork of this period, it was not absolutely vital that the worked face was exactly 90° to the bed face. This could be 'taken up' by altering the bedding of the brick into the mortar during the laying process, tilting it backwards or forwards to achieve 'face-plane' to the surrounding facework. Where it was necessary to have the face at 90° to the bed, this could be achieved by marking up from the bed on to the header face at either end with the 'try- square'. One could then scribe the two lines across to meet one another along the top of the brick, and then 'work' the brick face 'true' to those marks.

Practical tests, as discussed above, appear to indicate that the brick being axed to finish would sit flat on a sturdy workbench, then termed the 'chopping-block'. It would be positioned face up and resting on what is traditionally termed a 'softing', usually some thick hessian sacking that helps to take the jarring action of the blows, thus preventing the brick being damaged.

The brick is positioned and held at the desired angle, rather than turning the blade of the axe, so that the brick axe is used with its blades parallel to the hewer, thus producing the diagonal axing marks on the face of the brick. The brick axe, used in a chopping-action, is worked from the top to bottom corner towards the hewer, which allows the cutting surface to be seen and position of the blade to be judged to maintain parallel lines. Care needs to be exercised when starting and finishing to prevent dislodging the corners, where it is found best to utilise the side edge of the axe blade, gradually utilising the centre of the blade as one crosses the full width of the brick face.

Tests on working mouldings also served to confirm the two methods proposed above. For 'squints', 'cants' and 'shouldered-bullnose' brick shapes, the axing method would remain diagonal to the stretcher and header faces. For more ornate profiles, such as curved and projecting enrichments, the axe strokes would either be horizontal, vertical or parallel to the shape produced (Figure 17). This would be achieved by working the outline of the desired profile at either end of the brick, having first cut out waste shapes with the tin saw, and then axing the profile required at either end, treating them as draughts. Once exact, the whole brick face is axed and abraded to shape from one side to the other.



*Figure 17 *Cut-moulded voussoirs with various styled axing strokes at Kirby Muxloe Castle (Leicestershire), 1483.*

The aesthetic choice as to whether to leave axe or drag strokes visible on the brick face or rub smooth (more easy with low-fired historic bricks than their modern counterparts) is (as it was in the past) down to time, finance, the final viewing position and level of craftsmanship.

The significance of the brick axe to the skilled Tudor city bricklayer is evident in a study of the design of the coat of arms of the Worshipful Company of Tylers and Bricklayers, granted their Royal Charter by Queen Elizabeth I on the 3rd August 1568. The extended arm above the armorial shield shows a hand clasping a brick axe, as opposed to the brick trowel one might expect to see. Company rules excluded 'aliens', emphasising that, by then, the best native craftsmen (and not just the Flemish) were very capable of working bricks post-fired. English craftsmen must always have had the opportunity, even in the earliest times, to learn from Flemish 'hewers'. This fact is clearly shown in a letter of c.1440 concerning the preparation and cutting of an ornate chimney at Havering-atte-Bower (Essex), as reproduced by Ryan (1996, 57):

Ye well ordeyne me a Mason that ys a ducher or flemynge that canne make a dowbell chemeney of ye brykke ... and yf ye may no flemynge have then I wold have an engelesche man and he were a yong man for a yonger man ys sharpest of wittes and of cunnyng [skill],

Abrasives

The rubbing of both individual bricks and completed enrichments, to achieve shape or finish on cut and rubbed brickwork, is a practice again steeped in the traditions of stone masonry; particularly of working soft stone. For abrading bricks on the banker, depending on the relative hardness of the individual bricks and the detail the craftsman was shaping, the hewer might use an appropriately sized metal file, rasp, or 'riffler'.

Files

The many tiny chisel-like teeth of the metal file all point in the direction in which it must be pushed in order to be effective. According to Salaman (1975, 619):

A treatise of 1100AD mentions files of square, round, triangular and other shapes. At this time files were made of carburized steel that could be hardened after completion of the cutting, which was done with either a sharp, chisel-like hammer or chisel and hammer.

Files would have been used for finishing, as little material is removed with each stroke. They are also suited to smoothing a rough workpiece or altering its shape in substantial detail.

Rasps

Rasps or, more correctly rasp-cut files, have a series of individual teeth produced on the abrading surface of the metal by a sharp, narrow punch-like chisel. The resultant rough-cut is suited to soft substances, such as wood, soft stone, and brick, and allows the fast removal of waste material and cleaning of small areas.

Rifflers

Rifflers are simply small rasps, of varying degrees of fineness, on a stem shaped to a variety of configurations used for cleaning and smoothing small and difficult parts of a worked soft stone or a cut-brick moulding.

Alternatively he might use suitably shaped hand-held stones, or a suitable piece of wood as an abrasive.

Hand Stones

These various abrading tools would only have been used within the cutting shed to prepare the cut brick prior to setting. The hand-held stones could, however, be used in the workshop and where desired, finish the brick surface *in situ*. Generally sandstone would be preferred and the stones could be square, oblong, flat or curved, cut to shape by the mason or brick hewer, to suit the purpose. Clearly for most medieval and Tudor post-fired brick dressings, hewers were happy to leave the axing strokes visible. When necessary, as on the inner window voussoirs to the north circular stairwell of the guardroom at Kirby Muxloe Castle, Leicestershire, (1483 the brickwork was clearly rubbed to follow the inner curve of the walling, so leaving a smooth-abraded finish (Figure 18).

It has been frequently suggested that bricklayers may have substituted part of a brick for hand-held stone to rub over the finished brickwork. Occasionally this may have taken place, but experience dictates it was not common, as a brick abrasive wears away relatively quickly, reducing its effect, and creates double the hazardous dust, all avoided with a proper hand-stone.

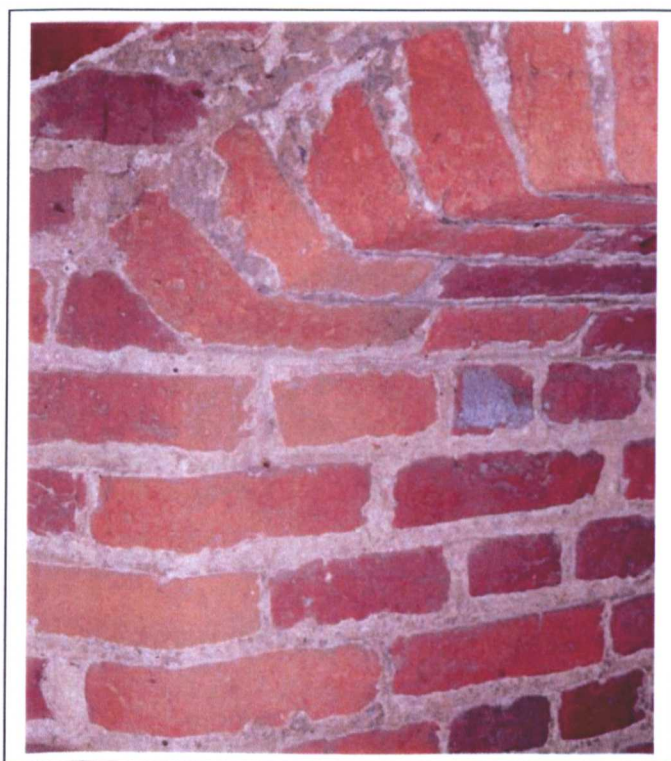


Figure 18 Axed brickwork face to a circular stairwell rubbed smooth at Kirby Muxloe Castle (Leicestershire), 1483.

Timber

The use of a suitably sized and shaped timber batten may appear to be a strange abrasive, but practical experience has demonstrated that it can serve to abrade a surface providing the brick is relatively soft textured and the wood is sufficiently hard and has a pronounced grain.

Summary

The Medieval and Tudor periods witnessed brickwork firmly establishing itself as a rival to stonework for the masonry of properties belonging to aristocrats and wealthy landed gentry. Through foreign influence, and primarily that of the highly skilled immigrant Flemish bricklayers, the best of these men established post-fired working of bricks, (primarily using brick axes, hand-saws, and abrasives) began to rival the work of the stonemason on Gothic enrichments. The craft practices that developed subsequently were the culmination of vernacular traditions dictated by available materials, budget, and time constraints imposed on the project, and the all-important levels of skill, knowledge, and ingenuity that individual craftsmen imparted to their work.

2.2 JACOBEOAN AND RESTORATION PERIOD (1603-1660)

As Colvin (1982, 37-38) says of the Jacobean period and its brickwork:

Building materials and techniques underwent no conspicuous change in the early years of James I.... Brick remained, of course, the basic structural material, whether stone-faced, rendered, painted or exposed.... Inigo Jones seems to have encouraged the interpretation of classical features in brick... at the Prince's Lodging at Newmarket (1619-21) the chimney-shafts had Tuscan heads of 'hewn bricks'. At James I's banqueting house at Theobalds (1625) the brickwork was 'hewed with an axe' and rendered; but at the repository for the king's clocks at Whitehall (1635-6) the brickwork was 'neatly axed and joyned' and evidently exposed. An early appearance of gauged, [or fine cut and rubbed], brickwork seems to be recorded at Greenwich (1623-4) where rustic piers were formed with bricks 'rubbed and polished'.

Clearly the gradual movement in architecture away from the gothic detailing of the Tudor period to that of the classical, and the use of brick instead of stone, was leading to an ever-refined use of cut and rubbed brickwork; not intended to be covered by stucco. The desire was to set the brickwork with ever-tighter joints to reduce their distracting impact on the enrichment or overall facade.

The Jacobean Period (1603-1649) was a time of immense architectural change. The Renaissance, or 'Re-birth', began in Italy during the fifteenth century. There, influential designers and artists were the first to be influenced by an intellectual movement reviving the learning and artistic styles of classical Greece and Rome; the central emphasis being on symmetry, proportion, and space.

Andrea Palladio (1508-80) published *'Quattro Libri dell' Architettura'* in 1570, setting out his theories and illustrating his works, which was to be hugely influential on Inigo Jones (1573-1652). Jones was the first English architect to be truly conversant with the rules of classical architecture; whose architectural style was later to become associated with Palladianism.

Sir Henry Wotton (1568-1639), English traveller, scholar and diplomat, had been appointed as Special Envoy to The Hague in 1624. He was long acquainted with Inigo Jones at the Royal Court, as well as the Dutch architect Huygens, and by way of introduction to the works of Vitruvius, Lord Wooton published *Elements of Architecture* in the same year. This book reveals the classical influences that coloured much of the

work of influential Jones (who visited Holland in 1613 and who was very popular there) (Kuyper, 1980, 228) relates that this:

...is an indication of the impact of the ideas in Inigo Jones' environment on Dutch learned circles.

The effects of the Renaissance moved northwards from Italy into France in the sixteenth century, through the Netherlands and on into England. In each, local vernacular traditions influenced and altered the new style, giving each country its own unique interpretations and characteristic craft practice, as Stoesser-Johnston (2000, 121) records:

Decorational elements derived from classicism had arrived in England from Antwerp via Hans Vredeman de Vries, [1526-1609], *Architectura* (1563) and *Compertimenta* (1566).

Penoyre and Ryan (1958, 111-14) give a brief, yet sufficiently detailed, overview of this transitional phase in England at the close of the Elizabethan period and the following, overlapping Jacobean period, which helps one to understand the early effects of the Renaissance on domestic architecture, and by necessity its craftsmen:

It is by the mixture of Gothic ideas, like the hood mould over a window, with classical detail such as columns, broken pediments, and so forth, that Elizabethan work is most easily distinguished.... It was not till Inigo Jones came home from Italy that the Italian style began to influence the basic shape of buildings.... As the 17th century progressed, so the quality of the decorative work became more correct.

2.2.1 Brickmaking

The seventeenth century saw a considerable development in the quality of bricks, largely influenced by the practices of brickmakers from the Netherlands. Brick sizes altered during the period and some Jacobean bricks are larger than their Tudor counterparts (Lloyd, 1925, 12; citing a Proclamation of Charles I, 1625). Government law or statute regulated these, although usually reserved for London only, enforced by the powerful Tylers and Bricklayers Company. By 1622, to regulate the brick supply the Tylers and Bricklayers Company were entrusted with overall supervision of the brickmaking industry.

2.2.2 Master Bricklayer and the Architect

Several factors combined to make gauged brickwork emerge and consolidate its position in the seventeenth century.

- The increasing native assimilation of the Renaissance of classical architecture by a new class of designers - architects.
- The shift of importance in the development of architectural inspiration and innovation from Italy to northern European models; proliferated through builders 'pattern books', and combined with the movement to England of influential continental architects and master craftsmen.
- The ongoing refinement of the skills and knowledge of post-fired cutting and rubbing of bricks by city bricklayers for classical architectural enrichments.
- The continuing use of brick for the building of influential houses in and around London.

Until the middle of the seventeenth century, the design and control of a building, as it had from the Middle Ages, lay largely with the master mason or bricklayer. This manifested itself during the early Stuart period in the so-called Artisan Mannerist style of architecture, so called because of the licence the builders (artisans) took with the rules of classical architecture.

The word architect (from the Greek *architekton*, meaning builder-in chief) begins to be encountered during the latter part of the sixteenth century, but *Airs* (1995, 31,34) suggests:

...it is used in a vague and imprecise way.... However, even though the term 'architect' was loosely used in the sixteenth century, with a meaning that was not synonymous with that which is has now, many of the men to whom it was applied were clearly able to make designs. But most of them remained 'mechanics', employed as wage earners and servants of the builder.

In England, the client's wishes had a crucial influence on the overall layout of a building, but the master craftsmen had a continuing tradition of deciding the nature of mouldings and architectural detailing (*Airs*, 1995, 35):

...innovations, perhaps initiated by a few master craftsmen, were quickly absorbed into that tradition and spread by example from their place of origin throughout the rest of the country.

The foundation of Renaissance architecture was intellectual and to understand its rules required at least dedicated book learning and, if possible, travel abroad to witness first-hand its effects.

During the late sixteenth and seventeenth centuries, wealthy noblemen, patrons with a keen interest in classical European architecture, were travelling abroad and amassing libraries of foreign architectural books. This served to advance the arrival of the architect. This, however, caused much resentment from the master craftsmen, most of whom lacked a full formal education, complete access to Renaissance designs and the opportunity to travel abroad, As Airs (1995, 49) states:

The well-known dispute between Inigo Jones and Ben Jonson was partly a reflection of this battle for the status of the architect.

Ben Jonson, soldier, actor and playwright, was also a time-served city bricklayer, who had spent time in Flanders, and was a freeman of the Tylers and Bricklayers Company. His undoubted experience working with the trowel must have been of interest and value to Inigo Jones; and it seems inconceivable that they would not have discussed the use of brick in buildings.

This was a radical change in the control of design and execution of English architecture. From this point onwards the influence of the architect as opposed to the master builder on the design and control of a new building, was becoming more significant. It was important that someone with understanding and knowledge of the subject was in charge, although the client in consultation with his skilled craftsman traditionally decided details as the building progressed.

2.2.3 The Artisan Mannerist Movement

Master craftsmen were not going to release easily the privileged status that they had historically enjoyed and were determined to acquaint themselves with the pattern books arriving into seventeenth-century England 'via the free interpretations of the Low Countries' (Airs, 1995, 35).

Mowl and Earnshaw (1995, 8) suggest:

This problem of the iconography of a style had arisen partly from the wider use of brick as a building medium and partly from the innovations of Inigo Jones. In 1623 the London church of St. Giles, Cripplegate had been re-built in rubbed brick but to the design of...an Perpendicular gothic church....

Dutch influence was especially strong, in the 'Artisan Mannerist' style, with skilful handling of brick to shape and build columns, pilasters, moulded openings, architraves, and pediments, following mainly classical profiles. These displayed a wealth of finer brickwork advancing the skills previously required for the preparation of gothic-styled Tudor tracery, arch labels, and ornate chimneystacks. The Dutch House, Kew Gardens, (London) (c.1631) is an influential example of the style. Others are Cromwell House in Highgate (London) (c.1637-40), Broome Park (Kent) (1635-38), Balls Park (Hertfordshire) (c.1640), Tyttenhanger Park (Hertfordshire) (c.1655), and Swakeleys (Middlesex) (1638).

The 'Dutch House' in London, as it was called for over a century after it was built, is known today as 'Kew Palace', and was built for a wealthy merchant of Dutch origin called Samuel Fortrey, it is frequently given as the earliest example of English gauged brickwork (Lloyd, 1925, 15; Brunskill and Clifton Taylor, 1977, 26). It is perhaps better described as a good example of the transition of the Artisan Mannerist style, employing post-fired brickwork for enrichments, from the earlier Tudor Gothic 'cut and rubbed' work, prior to the later, and more refined, classical use of the true Dutch style of employing gauged brickwork.

The 13 Building Articles for the properties in the parish of St Paul, Convent Garden, in London, emphasise this fashion for post-fired worked brickwork of the second quarter of the seventeenth century, 'The revised articles required the house fronts to be built of 'hewed or well rub'd brices...' (Sheppard, 1970, 30):

Cromwell House in Highgate, London (1637) (despite poorly applied and inappropriate modern re-pointing) has a delightful central first-floor window opening, set with a lugged architrave, with volutes and scrolled consoles (Figure 19). This would appear to indicate *in situ* carving. At Tyttenhanger Park in St Albans, (Hertfordshire) (1655) (Figure 20) (another victim of modern re-pointing) is a later and more finely executed example of the same cut and rubbed central detailing to the first-floor window. The bricks for this

enrichment are of a better quality for cutting and rubbing than those employed at Cromwell House, 18 years earlier. It is not impossible that the detailing for both windows was designed and executed by the same craftsmen.



Figure 19 Cut and rubbed 'lugged' window detailing at Cromwell House, London, 1637.



Figure 20 Similar, but later 'lugged' window detailing at Tyttenhanger Park, Hertfordshire, 1655.

Through the popular use of brick for properties designed in the classical or Mannerist fashions, the use of cut and rubbed ashlar and moulded brick was increased. At the Queen's House at Greenwich in London (1635-6), Colvin (1982, 119; citing National

Archive Reference E351/3269) records the moved and re-built gate piers as '...two rustique Peeres with bricke rubbed and polished.'

The term 'rustic' indicates the practice of chamfering the horizontal or vertical (or both) arrises of selected bricks, or indenting, to create a 'blocked' effect to emphasise the masonry and create an impression of massiveness, impregnability and strength. This is seen with the 'noble piers' at Lincoln's Inn Fields, London (Figure 21).



Figure 21 The gauged 'blocked' or 'rusticated' piers at Lincoln's Inn Fields, London, date unknown, but believed to have been removed and re-built in the mid-eighteenth century (The London County Council).

Peacock's (sometimes referred to as Pocock's) School at Rye (Sussex) (c.1638) shows adaptation of the Tuscan order to brick, which Lloyd (1925, 76-7), quotes the architect Sir Reginald Blomfield, who says the designer:

... made no attempt to adhere exactly to the orthodox rules of the Tuscan order.... Yet the work is by no means ignorant... The arches over the window are straight brick arches, channelled [rusticated] to form voussoirs and key-blocks. These are rubbed brick, but coarsely jointed.

It must be remembered that the 'coarse jointed' description may not have originally appeared as severe, due to the practice of colour washing some principal elevations with ochres ('ockering' or 'ruddeling'). This was done to regularise the various tones of brick colour, the joints being then picked-out, to a reduced size, with white or black coloured distemper applied by the bricklayers using a thin brush. This practice is referred to in accounts as 'pencylling'. Certain cut and rubbed brickwork might still be stuccoed during this period. In terms of finishing exposed cut and rubbed work, one finds references not only to it being 'rubbed' or 'polished', but also, as at Somerset House, London (1609-13) to the chimney stacks undergoing 'polishing and rauncering'. This as Colvin (1982, 257) suggests 'presumably gave the appearance of polished rance'. The term 'rance' is according to Colvin (1982, 33) 'a veined, dingy-red marble, from Tournai in France'.

The tools and cutting techniques used by the craftsmen preparing post-fired worked bricks were largely as in the previous periods. We therefore read of 'hewen chamfrette', at Theobalds (Hertfordshire) in 1607-10 (Colvin, 1982, 275). For Inigo Jones at Whitehall, London in 1625, we read of 'the brick woorke being hewed with the axe' and in Whitehall Palace, London in 1635 we read of brickwork 'neately axed and joynted [jointed]' (Colvin, 1982, 337).

Jigginstown House, in Naas, (Kildare, Eire), was built in the Mannerist fashion by the Lord Lieutenant of Ireland, the Earl of Strafford (1593-1641), during the reign of King Charles I. In the conserved ruins of the once magnificent brick property, one can still observe the decorative cut and rubbed enrichments. Linear emphasis is achieved through cut and rubbed moulded plinth, platt band and cornice picked-out in very small (180 x 83 x 38 mm) yellow bricks, which are in contrast with the standard size of red bricks used for main elevations. An annotated drawing of 1726 by Edward Lovett Pearce, artist and draughtsman, for his client Richard Boyle, 3rd Earl of Cork, shows architectural detail incorrectly described in contemporary language as 'rub'd and gadged' (Figure 22).

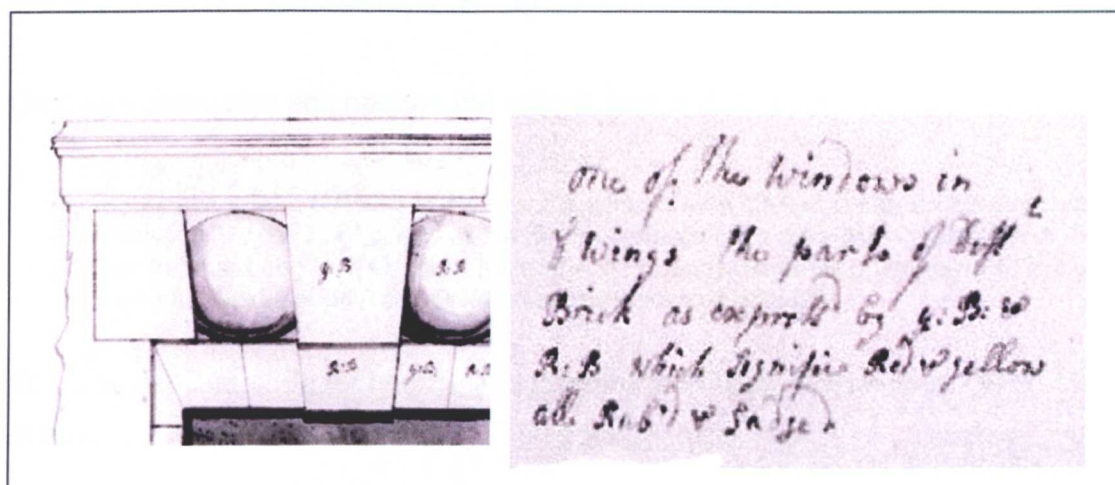


Figure 22 A detail from a drawing (1726) of cut brick detailing, Jigginstown House, Naas, Co. Kildare, Eire, c.1635-41 (drawing number 4, Devonshire Collections, Chatsworth, Derbyshire, England).

2.2.4 Prominent Artisan Architects and Master Craftsmen

The name of a significant master bricklayer who had both a strong connections with the Artisan Mannerist movement and the transition from accurate 'cut and rubbed' work to precise gauged brickwork is Peter Mills (1597-1670). He was the son of John Mills, a tailor in East Dean, (West Sussex), he became apprenticed to John Williams, Tyler and Bricklayer of London, on 30th November 1613 (Colvin, 1995, 390-91). Mills himself took his first apprentice in 1629 and during this period he was to work professionally with Inigo Jones and his influential architect pupil, John Webb (1621-67).

On 17th October 1643, Mills was appointed 'Bricklayer to the City of London'. As a sign of his regard, both within his livery company and the craft itself, he was also made 'Master of the Tylers and Bricklayers' Company' in 1649-50 and again in 1659-60 (Bell, 1938, 68).

Peter Mills was a highly qualified, prominent individual who played a major role in taking English domestic architecture out of the Tudor/Elizabethan models. He must surely have used his craftsmanship and influence to help advance the skill base of his craft to a new level of use and quality. This would have served as a springboard for the highly

capable city bricklayers of the post-Restoration Period, to be readily able to absorb and use the advanced Dutch skills of refined gauged brickwork.

Godfrey (1946, 168) emphasises the contribution that Mills made to architecture:

In 1639 a scheme of building in the new Italian style was started in Great Queen Street and Lincoln's Inn Fields. The houses in the former have unfortunately been pulled down. They appear to have been built by Peter Mills who in his early career was bricklayer to the City of London, but rapidly acquired reputation as surveyor and architect.

Of the Great Queen Street houses and Lincolns Inn Fields, Summerson (1947, 18-19) states:

The Great Queen Street houses were reputed, in the 18th century, to constitute "the first regular street in London". They laid down the canon of street design which put an end to gabled individualism, and provided a discipline for London's streets, which was accepted for more than two hundred years....

In Lincoln's Inn Fields... (Nos. 59-60) under the name of Lindsay House...is one of the many buildings of the kind which is attributed (on the evidence of Colin Campbell) to Inigo Jones himself. Its brickwork is covered with stucco, though the fine brickwork of the original fore-court piers is still exposed.

Summerson (1953, 102) suggests the architect for this property may not have been Jones, but rather the influential master mason, Nicholas Stone. Stone is discussed in possible connection with the introduction of early English gauged brickwork. Peter Mills and Nicholas Stone, both of whom had worked with Inigo Jones, were familiar with brick and stone at the highest level of preparation and application; so it is not surprising that either man's name may be placed against early English gauged brickwork.

The aforementioned forecourt brick piers are themselves of importance and are mentioned by Gomme and Norman (1932, 97) as 'Two noble piers of brick, surmounted by lofty carved stone terminals, stand in the courtyard and were justly praised by Hatton in 1708'.

These 'noble piers' (recently restored by Nimbus Conservation Limited) are of rusticated brickwork, which, if original, are an early example of quality gauged work. It is probable that the brickwork is later - 'It may therefore be suggested that these piers were removed to their present position when the premises were divided in 1751-52' (Gomme and Norman, 1932, 98).

With regard to the early introduction of gauged brickwork into England, a good example may be seen in the remains of the classical entrance porch to the north elevation of Houghton House in Ampthill (Bedfordshire) (now a ruin). The ashlar gauged work of orange fine-textured rubbers is, as yet, undated, but possibly c1617-18 and thought to be to the designs of Inigo Jones (1573-1652), commissioned after the house was completed in 1615. Of Houghton House (Figure 23), Harris and Higgott (1990, 84-85), record:

The most tantalising and grand commission of these year years is Houghton ... possibly begun just before Jones returned from Italy... It is possible that in the building process she [Mary, Dowager Countess of Pembroke] was persuaded to provide modernity to the house by inserting classical frontispieces into the north and west fronts. These could only be by Jones, so classical are they in Jacobean England. As such, they are precious relics of his designing skills in this early period, probably in mid-1615 and certainly before 1621 when the Countess died.



Figure 23 An eighteenth-century drawing of the entrance loggia on the north elevation of Houghton House, Ampthill (Bedfordshire), 1615 (Society for the Protection of Ancient Buildings archives).

This is very significant, as the brickwork, though with varying joint sizes and lacking the highly disciplined nature of the post-Restoration, work is of a much higher standard than Kew Palace; yet clearly predates it by a decade or more. It would now surely be correct to recognise Houghton House (Figure 24) as the first building on which gauged brickwork was introduced into England.

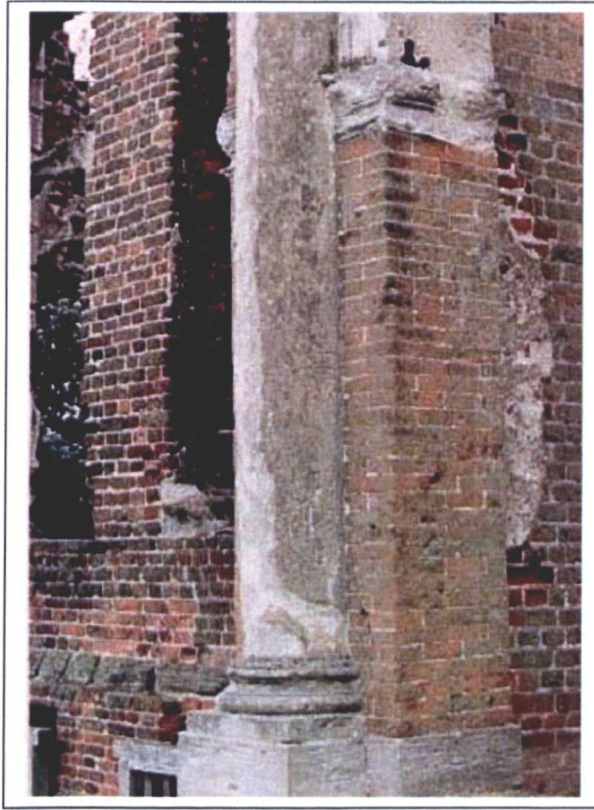


Figure 24 Early gauged brickwork detailing to Houghton House, Ampthill (Bedfordshire), 1615.

It is important to note, however that some authorities think the design of this once large loggia, with its early gauged work, is too 'mannered' for Jones in which case a strong candidate is master mason and sculptor, Nicholas Stone the Elder (1586-1647. (Harris and Higgott, 1990, 155) record:

One architect in Jones's entourage whose work is both distinguished and singular is Nicholas Stone, the mason of the Banqueting House and master mason to the Crown from 1632, deeply read in continental treatises... Stone created a Mannerist style that is not 'artisan', but stems directly from the northern Italian Renaissance.

One cannot but be struck by the similarity of the overall design of the drawing for the original north-facing classical entrance porch at Houghton House and the principal facade of 'Huis Bartolotti' in Herengracht, Amsterdam (1617) (Figure 25) (designed by De Keyser). De Keyser single-handedly created what is known today in Holland, as the 'Amsterdam Renaissance style'. Kuyper (1980, 29), emphasises his influence on Nicholas Stone by saying '... his manner is stylistically so close to his master's....'

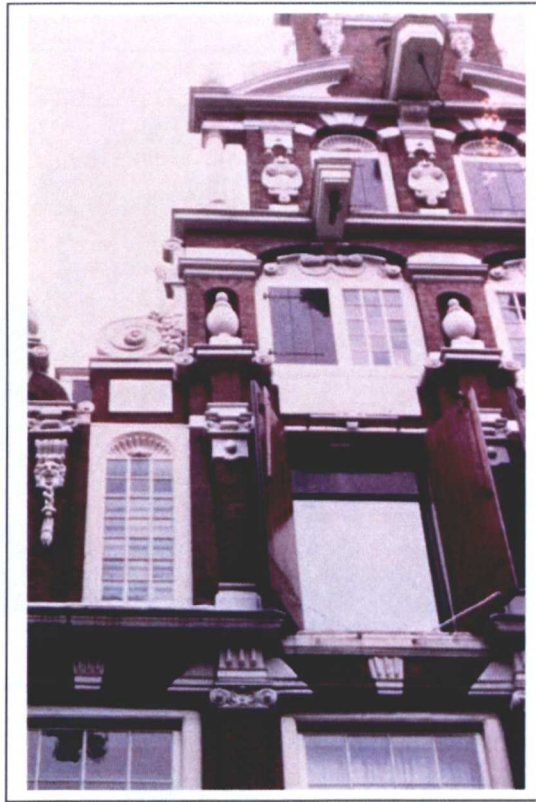
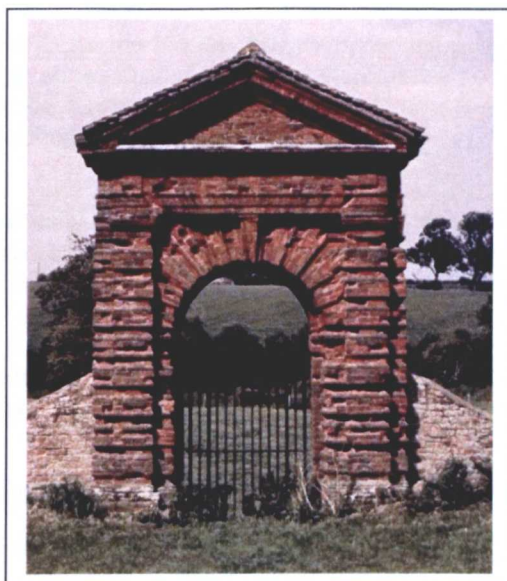


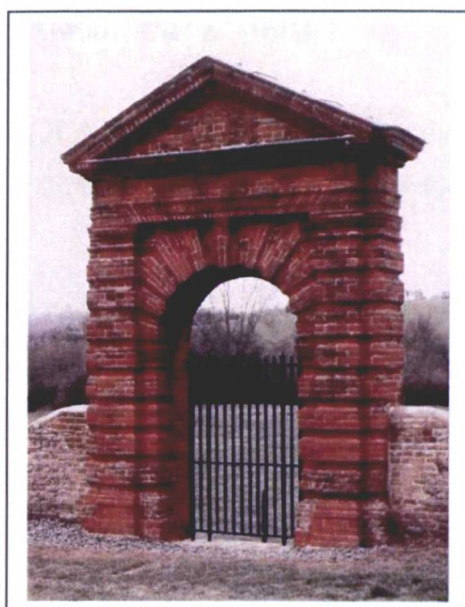
Figure 25 Huis Bartolotti, Herengracht, Amsterdam, Netherlands, by Hendrick de Keyser, 1617, (Joop Hofmijeer).

Nicholas Stone, could not have been immune to, or unaware of, the great craftsmanship of early seventeenth-century post-fired cut-moulded brickwork blossoming in the hugely influential city of Amsterdam during his years living and working there. He would naturally have sought to use brick in a high-class fashion as a facade masonry material; whether to his own designs or that of another, such as Jones.

An important and high-quality gauged brick construction with possible links to the Stone family is the impressive rusticated, pedimented and arched brick gateway at Chesterton (Warwickshire) (Figures 26 and 27). The author advised on the restoration of the gauged work for the architect Eric Davies, and the works were carried out by Messrs Linford-Bridgeman in 1991.



*Figure 26 *The Chesterton gateway (Warwickshire), c. 1662, before restoration in 1987.*



*Figure 27 *The Chesterton gateway (Warwickshire), c. 1662, after restoration in 1991.*

Set into the north wall of the nearby churchyard, it was originally the private entrance to the church from neighbouring Chesterton House (demolished in 1802), owned by the Peyto family. The gateway, as yet undated, is undoubtedly a fine example of ornamental gauged brickwork. The design has been traditionally accorded to Jones (Lloyd, 1925, 83, 317,412), but as Wise (2000, 155-56) counters '...most authorities place the date of the Peyto Gateway rather later in the seventeenth century'.

Wise continues:

The surviving accounts for the House, however, record its construction between 1657 and 1662 and, given that Jones died in 1652 he cannot have been the architect.... surviving documentary evidence suggests that Chesterton House is the work of John Stone (1620-1667), the son of Nicholas Stone.

John Stone was certainly employed by the Peyto family at this period...in October 1659 Elizabeth Peyto gave £1 to 'Mr Stone for drawing the draught of the head of the pillars for Chesterton'. In the following year she paid John Stone £2 'for the 2 capitalls of the arch at the staires'....

...but the continuous patronage of the Stones, father and son, by the Peyto family over some twenty years strongly supports the identification of John Stone as the architect in this case.

There are some doubts as to John's practical skills, (most likely due to his original education towards a religious life), but he was acknowledged as a good designer/architect. He employed a regular small staff, including his Dutch cousins (De Keyzers) and several other craftsmen from the Low Countries, as well the Danish master sculptor Caius Gabriel Cibber (1630-1700).

Payments to John Stone by the Peyto family for his work, as described above, in 1659 and early 1660 and of Cibber's work there later in 1660, are explained by Spiers (1919, 28):

...that he [John Stone] went over to Breda [Netherlands] with the intention of petitioning the King for the grant of the office of Master Mason of Windsor held by his father; whilst there, however, he had a violent attack of the palsy, which deprived him of the use of his limbs, and incidentally we also learn from Vertue's own MSS [Brit. Mus. Add. MS. 23069, f.4.], that Caius Gabriel Cibber, who was then his foreman, went over to Holland to bring his master home...

Stone was awarded the position for which he had petitioned the King in August 1660, but later sold it to a competitor, Joshua Marshall, due to continuing ill health. He died in September 1667.

The construction of the Chesterton gateway is now widely believed to be contemporary with that of the house. Certainly the quality of craftsmanship is at the higher level which, one begins to be seen developing out of the earlier cut and rubbed work and which immediately precedes the very precise gauged brickwork, seen in the post-Restoration period. That stonemasons, or indeed the best master bricklayers, who could work, when required as masons, may have erected this gateway is not surprising given the history of these two branches of masonry. The nature of the construction, particularly of

the rusticated arch, is highly suggestive of craftsmen very familiar with stonemasonry skills.

Close examination of the soffit to the rusticated arch, which provided shelter from the weather, reveals the 'blinding-out' of the mortar joints to match the colour of the bricks; creating an homogenous appearance to the overall masonry. This could have been achieved by several different methods. Rubbing-up the wall whilst it still retained some moisture in the bricks forced part of the resultant dust to adhere on the faces of the mortar joints. Alternatively, the joints could have been 'stopped-up' with an ochred pointing mortar to also achieve the same result, and/or a final colour wash applied. The visual evidence further suggests that these blinded joints were lightly 'struck' then 'ruled', and possibly 'pencylled' to finish.

The remarkable changes in the first half of the seventeenth century in domestic architecture produced ever improving standards of brickwork, manifesting itself in a higher level of skill in working post-fired enrichments. The influence of key personnel, like Nicholas Stone and Peter Mills, cannot be over emphasised in how they enabled English post-Restoration architects and craftsmen to absorb, design, and deliver classical gauged brickwork. It is in the fine work of the century from the 1670s that we truly witness the finest expression of English brickwork and, again, this influence was from the Netherlands and, in particular, the provinces of North and South Holland.

2.2.5 The Dutch Influence on English Classical Gauged Work

By 1609 the seven united provinces in the Netherlands, of which North and South Holland were pre-eminent, became independent of Spanish rule. Within only a few decades they experienced a 'Golden Age' of culture, prosperity, and influence, with the Netherlands emerging as a major world power. The united provinces benefited from the thousands of Flemish refugee craftsmen and designers who had moved north to escape Spanish and religious persecution. From the early seventeenth century, one begins to witness Flemish craft skills of 'Berwekte Baksteen' or 'worked-on bricks', appearing on Dutch buildings, serving as a prelude to their gauged brickwork.

This arrival of Flemish craftsmen in Holland was coincidentally at the dawn of a Renaissance style (called 'Dutch Mannerism') of architecture that followed the close of their Gothic period. By 1600 the style was referred to as 'Dutch Renaissance' and, by

1615, 'Amsterdam Renaissance'. 'Dutch classicism' began to appear in 1625, inspired by such architects as Jacob van Campen (1595-1657), Constantine Huygens (1595-1687), Pieter Post (1608-69), Arent Van's-Gravensande (1599-1662), Philip Vingboons (1607-78), and his brother Justus (1620-98). It enjoyed its heyday between 1640 and 1665, and it was this style, strictly following the rules of Italian treatises, that was to become popular in post-Restoration London, and to bring with it the prolific use of gauged brickwork.

Dutch master bricklayer Joop Hofmeijer reveals that Dutch gauged work is concentrated mainly in the south and west of the Netherlands running on into Flanders; no examples being extant in the east or north of the country (Hofmeijer, 1997).

The skill of gauged brickwork was, and still is, referred to in the Netherlands by the term 'geslepen metselwerk', which literally translated means 'sharpened brickwork'; a term that is beautifully descriptive of the practice of grinding, cutting and shaping the selected bricks to precise arisses for accurate setting. It was used mainly in the seventeenth and eighteenth centuries, but to nothing approaching the extent of its proliferation in Flanders.

Traditionally the best of top-grade bricks selected for face work, those that were perfectly baked, rather than burned, were reserved for gauged work. A particularly popular source of bricks was the Leiden (Leyden) region, where the downwash alluvial clay was very clean and refined, and therefore perfect for a rubbing brick or 'Leide Steen' or 'Leiden brick'. Ironically there is no Dutch term for a brick selected as a rubbing brick.

Studying the early Dutch gauged work one can clearly see the use of the steenschaaf to dress and finish the brick enrichment in the Flemish manner (Figure 28). It is noticeable, however, that within a relatively short time-scale, a rubbed-smooth finish to the work replaces this technique. This is almost certainly due to realising the greater potential to abrade softer, clean-bodied Dutch bricks compared to their harder Flemish counterparts.



*Figure 28 *A 'Steenschaafed' finish to an arch face, 64, Breestraats, Leiden, Netherlands, 1635.*

The guild system, particularly in the wealthy province of Holland, during the seventeenth century established very high standards, by means of rules, for the production of a 'gildeproeven' or masterpiece by apprentices this is remarkably similar to the earlier, sixteenth-century, 'Proefstukken' models demanded by the Flemish guilds (Van der Horst, 1998). As in Flanders these were for the final-year apprentices demonstrating mastery to their mentors. 'Geslepen metselwerk', or gauged brickwork was the supreme test, requiring knowledge of measurement, setting out, geometry, fine skills in cutting and shaping bricks, and in setting and finishing the brickwork (Kurpershoek, 1997, 18-29).

Although not all bricklayer guilds in the Netherlands demanded this high level of proof, the consummate expression of Dutch gauged brickwork is to be seen in De Waag, Amsterdam. In the 'metselaargildekamer' (bricklayer's guild room), used by the city bricklayers from 1617, more than 80 masterpieces, niches, oblique bullseye windows, and ornate ashlar panels of very accurate and artistic gauged brickwork adorn several walls, including the spiralled entrance staircase, where the work follows the angle of rake (incline) (Figure 29).



Figure 29 Early seventeenth-century gauged work following the spiralled staircase to the former 'Metselaarsgildekamer', De Waag, St Anthienspoort, Amsterdam, Netherlands.

The rubbed smooth brickwork of orange/red rubbing bricks is laid in regular Flemish or English bond with putty lime: silver sand joints of 1-2 mm in thickness. They mainly date from the second quarter of the seventeenth century, 1650 up to about 1660 (Van der Horst, 1998), and are very similar to the best of post-Restoration English gauged brickwork in all respects; undoubtedly the work of bricklayers rather than masons. The influence on English work is without dispute (Figures 30 and 31).



Figure 30 Hood of a seventeenth-century gauged niche masterpiece, De Waag, Amsterdam.



Figure 31 Exquisite premier 1660 masterpiece, De Waag, Amsterdam.*

Surprisingly, the use of this exquisite level of gauged brickwork for enrichments on Dutch properties appears restricted to use largely on flat arches, and one is disappointed not to see anything matching the work of De Waag. Clearly even in the wealthy city of Amsterdam where they had perfected the skill, gauged work did not establish itself as a popular fashion. Perhaps this is due to the legendary puritanical austerity of the Protestant Dutch, compared to flamboyant Catholic Flanders, or simply that the high degree of accuracy and quality of their standard face brickwork was deemed sufficient for a premier elevation.

Whilst the Netherlandish influence on gauged brickwork has relevance to this work, it is not prudent to go into it in any greater detail. For further information, see Lynch (1998) and Lynch and Watt (1998).

2.2.6 Dutch Bricklayers in Post-Restoration London

Taking into account the dramatic improvement in the character and quality of post-fired worked brickwork that results in the production of Dutch-styled classical gauged work, one has to consider the possibility that bricklayers from the Netherlands were working in England, especially alongside the influential and highly-skilled city craftsmen.

It is not impossible that Dutch bricklayers, possibly from Leiden or Amsterdam, did come to London to ply their craft. The collapse of the 'tulip mania' commodities in 1637 could have been one economic reason and later, in the post-Restoration period, they may have come for the extensive re-building work in the city following the Great Fire of 1666. A Royal Proclamation to consolidate the Building Act of 1667 allowed 'foreigners' (native craftsmen living outside the old city boundaries and in the surrounding shires) as well as 'aliens' (craftsmen from abroad) liberty to work as freemen on the re-building. Working alone, or as a 'gang', Dutch bricklayers would have found much work specialising in producing elements of gauged brickwork. To date, however, extensive research in England and in the Netherlands has failed to find evidence to support this theory.

The names of these bricklayers may, of course, be anonymous within building accounts listed under an English Master Craftsman, or they may have anglicised their names; a common practice for immigrants. Certainly the city master bricklayer, Edward Helder, (Holder), who was used by Wren on the Temple, has a Dutch surname, and his skills in gauged brickwork were undoubted (see section 2.3.3).

Discussion with various architectural historians in the Netherlands suggests that the idea of a proliferation of Dutch bricklayers working in London to be negligible and unlikely. Dirk De Vries (De Vries, 1998), a respected senior historian with the Dutch Monumentenzorg who discussed the possibility with his colleague and noted historical architect, Wouter Kuyper (Kuyper, 1998), upholds this view:

He (Kuyper) does not think that Dutch bricklayers came over to England, except two of four sons of Hendrick de Keyser, Willem (1613-74) and Hendrick the younger (1613-65).

It is of interest to note that Kuyper refers to these craftsmen as bricklayers, when we would term them stonemasons. The same terminological confusion does arise in Dutch transcripts, translated by a Dutch architectural historian, where many of the seventeenth-century master bricklayers, working out of Amsterdam, are sometimes referred to as stonemasons. One can see this as again, reinforcing the fact that when called upon these craftsmen could, and certainly did, cross from stonework to high-quality refined brickwork with consummate ease if called upon to do so.

Research has indicated that Willem and Hendrick De Keyser trained in England under their uncle, Nicholas Stone. By 1640, Willem was back in Amsterdam working as city mason from 1647-53. He then returned to England after he went bankrupt in 1658. Hendrick returned to London when Stone died in 1647.

If we are to accept that, in the main, Dutch bricklayers did not directly teach their fine skills in gauged work to the city bricklayers, then most clearly they learnt from them by several indirect means. From the Tudor and Jacobean bricklayer's work of hewing and rubbing brick mouldings, the Stuart craftsmen had simply continued to refine these skills, working with ever-improving bricks and demands for smaller mortar joints, through the architectural designs of the Artisan Mannerist movement, as influenced from the Netherlands. Craftsmen eagerly learning these new skills and techniques further reinforced this movement, made strong by the proliferation of pattern-books out of Antwerp.

Summary

The brickwork of the Jacobean and Restoration periods was influenced by a combination of factors, including architectural writings from the Continent with designs based on the Renaissance. The rise of the Artisan Mannerist movement saw the continued refinement of the skills of master bricklayers and masons. These men, working an ever-improving quality of post-fired bricks, were able to achieve a much higher degree of accuracy, essential for classical detailing. This movement was largely led by respected artisan designers and was the key link to the full acceptance and development of Dutch-styled gauged brickwork that flowered in the post-Restoration period.

2.3 POST-RESTORATION TO THE GEORGIAN PERIOD (1660-1714)

This period was brimming with fundamental changes in architectural styles and craft practices that had a tremendous effect on the influential city designers and bricklayers; stamping forever an indelible character on English brickwork. With it came the prolific use of a new, Dutch influenced, class of post-fired worked brickwork, prepared and set to precise standards of accuracy, and neatness, hitherto unknown, this quickly became known as 'gauged work'.

Commercially and politically, England was well acquainted with her wealthy and influential Dutch neighbour, as Kuyper (1980, 210) records:

For the seventeenth century Londoner, it was easier to travel from England to Holland than it was to visit Lincolnshire or Cornwall: even in 1700 it was easier for a London merchant to send a letter to a correspondent in Amsterdam than to a customer in Hull.

During the Interregnum, many aristocrats, members of the Royal Court, and their extensive Royalist entourage, were exiled to Europe. A large number spent time in the Netherlands, including King Charles II; who stayed at the Mauritshuis in The Hague on the eve of his return to England. At the highest level, therefore, this country was very alert to anything of note taking place in the economic and cultural circles of the Netherlands, and, in particular, the hugely rich and influential city of Amsterdam.

In terms of the Dutch architectural influence that brought with it the use of fine brickwork Kuyper (1980, 205) affirms:

A retrospective view shows that it was not only the severe Classicist style of between 1630 and 1670 that provided models for English architecture, but also De Keyser's earlier transitional manner and the later Dutch architecture of between 1670 and 1700, the so-called Flat style.

At the Restoration, in 1660, King Charles II reconstituted The Royal Office of Works, granting positions to most of those who had served him in exile. Commissioners, architects, and city craftsmen alike, their close professional and social inter-relationships spread rapidly and assimilated the new architectural styles, materials and craft practices that proliferate at this momentous time.

2.3.1 Brickmaking

The late seventeenth-century brickmakers developed more refined methods of sand moulding leading to greater accuracy. In this process the 'puddled' clay was dashed into the mould, which was dusted with sand, preventing the brick from sticking to the mould. This method of moulding produced a firm de-moulded 'green' brick and reduced drying time required prior to firing.

In the drying phase it was possible to lay out the green bricks on-edge immediately and within a few weeks to stack them into a 'hack', involving long rows built to a height of up to eight courses. When half-dry the rows of bricks would then be 'skintled' (scattered), set slantwise and further apart to complete drying. Hacking took between three to six weeks in which the brick lost about one quarter of its weight (Hammond, 1981, 19).

Firing bricks in clamps still dominated where demand was large, but occasional. Improvements in permanent kilns led to the introduction of the roofless 'scotch' kiln, which was essentially based on the principle of the clamp (Woodforde, 1976, 60). This was intermittent, more controllable, and less expensive on fuel (wood and coal), than its less sophisticated predecessors. As a general procedure the kiln-fired bricks would be lightly fired for several days to prevent warping, then the heat was increased for two or more days. The fire holes, which also acted as vents, were then blocked and the fire was allowed to burn out (Hammond, 1981, 22). The kiln had to be left to cool down between seven and ten days before finally removing and grading the bricks.

There can be little doubt that this form of moulding helped make a brick that was more suited to being readily abraded than its predecessor. The addition of sand also helps to prevent shrinkage, warping and cracking, and reduces the hardness of the brick body.

Naturally-occurring silica or, within certain limits, added silica sand is an important component within a rubbing brick. Providing one was located on the right type of clean, high-silica-bearing brickearth or clay, then the material for the rubbing bricks was the same as for standard bricks. It would not necessarily undergo any special treatment, such as washing, pugging and/or screening, to distinguish the bricks from the processes involved in normal clay preparation; especially if the brickmaker was on a rich seam of sieved down-washed alluvial material. Records are limited on this level of information, but absence of evidence must never be taken as evidence of absence.

Individual brickmakers would do what was best to make a quality suitable to meet a booming market.

In the firing phase, however, more care might be exercised, such as placing bricks to be used as rubbers within a protected area, what brickmakers term a 'box', within the clamp, to help ensure the desired temperature. Alternatively, they might be reserved for controlled kiln firing still possibly set within a box. This special treatment allowed for the extra price charged for rubbers, which could return a handsome profit over their standard bricks (Bolton and Hendry, 1940, Volume XV11, 54).

The rubbing bricks may be considered as those baked to a point just short of vitrification, within the kiln or clamp, either deliberately or naturally protected from the more intense heat by their proximity to the other bricks that went on to partial or full vitrification. A visit to a clamp that was in the process of being unloaded in Boom, near Antwerp, in which over 650,000 bricks had been fired showed the bricks to be carefully graded in terms of colour, hardness, and other criteria for quality and loaded on to pallets for dispatch. Amongst this wide variation of fired bricks it was possible to select bricks that were capable of being easily cut and rubbed (Figure. 32).

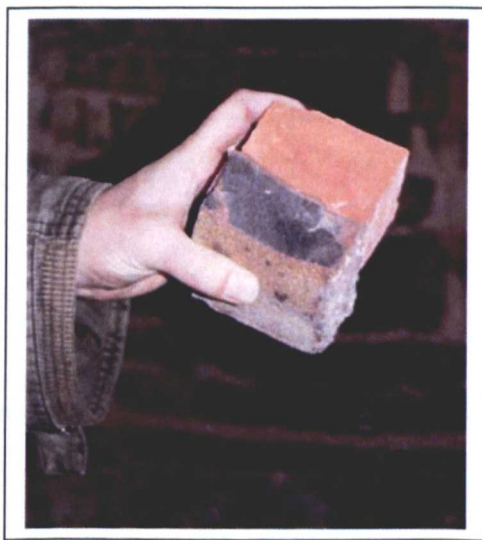


Figure 32 Baked and over-burnt brick from a clamp firing in Boom, near Antwerp, Belgium.

Preparation of a rubber has been described by Lamb and Shepherd (1996, 68-70). The brickearth was wash-milled and pumped into a 'washback' lined with sand, in which the material is allowed to settle and mature for several months. More sand was added when moulding the bricks, and, after drying they were kiln-fired at a temperature of 1,140°C. This, however, is far too generalised a description, some of which is better

suited to the second half of the nineteenth century; also the temperature of 1,140°C is too high.

Similar to the bricks from Aspley House and Winslow Hall, described below, the brickearth or clay would generally have been moulded by tempering to a soft consistency, using on-site sand to aid release from the timber mould/form. The bricks, after drying sufficiently, then have been fired, using mainly wood as the fuel with a lower overall temperature than coal, averaging 850-950°C. This temperature is significant, because at 900°C vitrification begins to occur, and a fireskin develops on the brick face. This prevents the brick performing as a rubber due to the increasing hardness and mineralogical changes within the brick.

It has been repeatedly shown through chemical analysis of traditional rubbers that the best of them come from a top stratum of down-wash alluvial silt and loam-like clean material. This has a naturally high silica content, such as indicated in Lamb and Shepherd (1996, 68-70) (Table 1):

Components	%
Silica (SiO ₂)	79.59
Alumina (Al ₂ O ₃)	9.88
Ferric oxide (Fe ₂ O ₃)	4.78
Magnesia (MgO)	0.95
Lime (CaO)	0.96
Soda (Na ₂ O)	0.82
Potash (K ₂ O)	2.10
Titania (TiO ₂)	0.80
Phosphorus pentoxide (P ₂ O ₅)	0.06
Nitric acid (HNO ₃)	0.06

Table 1 Typical Components of Brickearth (Lamb and Shepherd, 1996, 68-70).

The results of chemical analysis carried out on samples of both standard face bricks and augured brickearth taken from within the boundary of Aspley House in Aspley Guise (Bedfordshire) (1692) were similar to the above general analysis; in particular the high silica contents in excess of 80% (Table 2):

Components	%
Silica (SiO ₂)	82.7
Alumina (Al ₂ O ₃)	8.53
Ferric oxide (Fe ₂ O ₃)	4.88
Magnesia (MgO)	0.58
Lime (CaO)	0.36
Soda (Na ₂ O)	0.18
Potash (K ₂ O)	1.41
Titania (TiO ₂)	0.67
Phosphorus pentoxide (P ₂ O ₅)	0.09
Chromium sesquioxide (Cr ₂ O ₃)	0.01
Manganic oxide (Mn ₃ O ₄)	0.03
Zirconia (ZrO ₂)	0.07
Barium Oxide (BaO)	0.03

Table 2 Aspley House Brick Sample - Chemical Analysis (Ceram Research, 1996).

Geological tests carried out on samples collected from Aspley House indicated that the bricks had been made from the on-site brickearth (Prentice, 1996, 1-6). Furthermore, a print of a painting of Aspley House clearly shows how it was left standing high upon the original ground level due to the surrounding excavation for brickearth to the front and sides of the property. Today this mound and depression have been subtly landscaped (Figure 33).

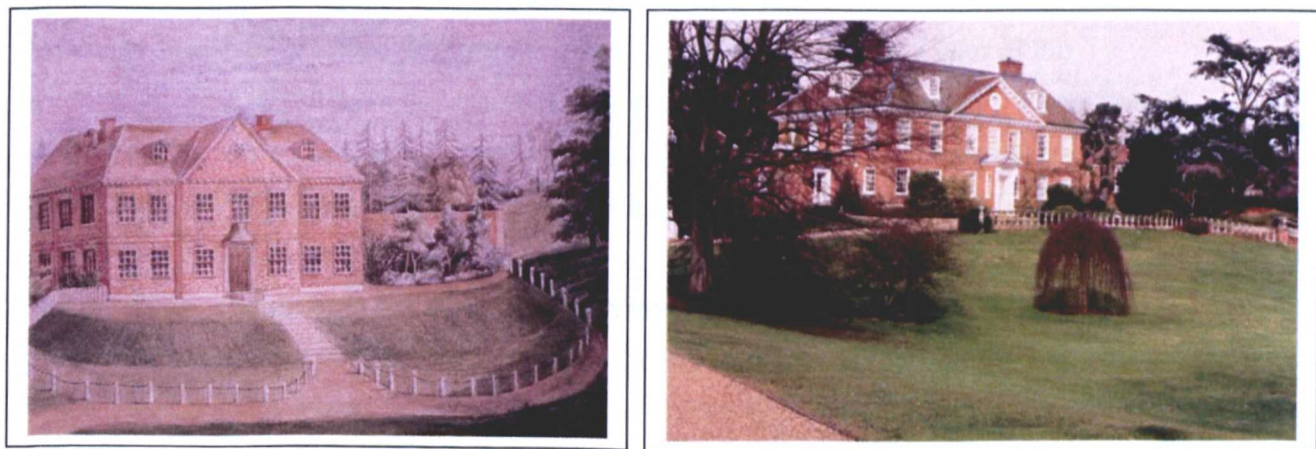


Figure 33 Print of c. 1800, showing Aspley House, Aspley Guise (Bedfordshire) 1692, clearly depicting the lowering of the ground to excavate the brickearth, alongside a photograph of the house today.

The use of brickearth from within the curtilage of Aspley House would have reduced brick costs by 50% or more. Searle (1936, 67) states '...an acre 1ft. [305 mm] deep, or about 1,600 cubic yards [1.223m³] of clay, will make 1,000,000 bricks'.

The huge numbers of bricks that were required for this property and the use of the on-site brickearth strongly suggest clamp rather than kiln-burnt bricks.

It was clear that the best of these Aspley House bricks in terms of regularity of shape, consistency of texture and colour were selected after firing for use as rubbers for the gauged enrichments (such as flat arches and platt band). Cutting and rubbing a number of these original face bricks during preparation for the above testing showed them to behave (300 years on) like the very best of rubbing bricks; clean-bodied with occasional small inclusions. These presented no difficulties and were very common in most rubbers up to the mid-nineteenth century.

As Prentice (1996, 1-2) states:

The house is situated on the outcrop of Lower Greensand (Cretaceous Age). This predominantly is a sand formation, and at first sight not thought of as suitable for the production of bricks. However, the lower stratigraphic level of this formation, on which 'Aspley House' is sited contain much argillaceous material, and could be used to produce a satisfactory, if somewhat weak, building brick.

Winslow Hall in Buckinghamshire (1698-1701) (Figure 34) was built by Sir William Lowndes (1652-1724) who, through his official position as the Chancellor of the Exchequer, was in professional communication with Sir Christopher Wren. Wren closely examined the accounts for the construction of Winslow Hall for the owner, records of which appear in *The Wren Society* (Bolton and Hendry, 1940, Volume XVII, 54).

The property, constructed in the Anglo-Dutch style, has gauged brick enrichments for the arches, reveals to the openings, piers in the front garden, and a vaulted basement. The master bricklayer was John Yeomans (Colvin, 1995, 1134).

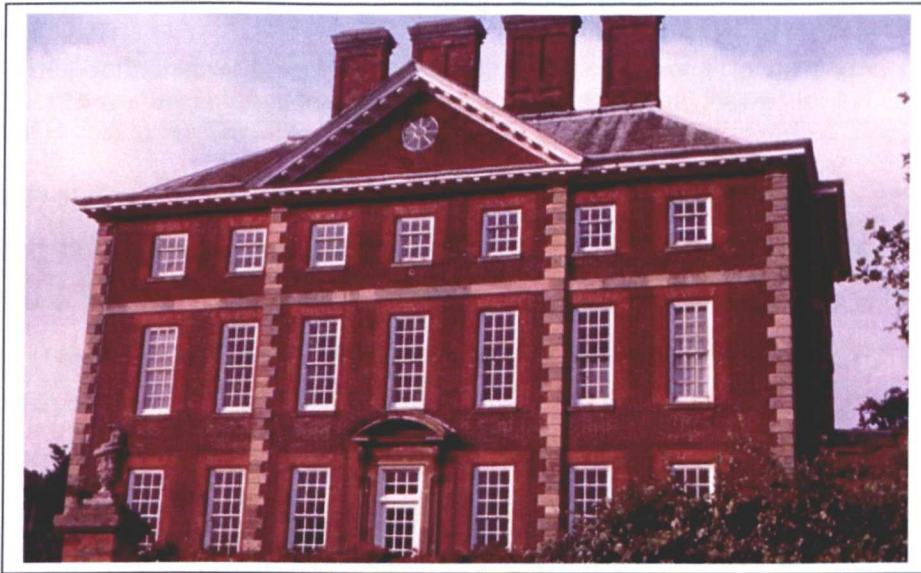


Figure 34 Winslow Hall, Winslow (Buckinghamshire), 1698-1701.

Transactions for the bricks made for Winslow Hall, are given as follows (Bolton and Hendry, 1940, Volume XVII, 54):

<i>No of Bricks</i>	<i>Bricks Made by</i>	<i>Location</i>	<i>Cost PM (1000)</i>	<i>£</i>	<i>s</i>	<i>d</i>
778700	John Stutsberry	Norden	14sh	545	1	10
51300	Margaret Deely	Winslow	17sh 6 ¹ / ₂ d	45	0	4
163850	John Spratley	Winslow	17sh 8 ¹ / ₂ d	145	5	3
5000	Richard Snag	Tattenhall	15sh	3	15	0
7000	Thomas Edmonds	Stukely	18sh	6	6	0
35000	From the old house pulled down	Winslow	14sh	24	10	0
<i>In all 1,040,850 Bricks burnt in Kilnes cost</i>				<i>£769.18.05d</i>		
<i>Rubbing bricks</i>			<i>Cost PM (1000)</i>	<i>£</i>	<i>s</i>	<i>d</i>
46200	John Stutsberry	Norden and Astons Lane	£1. 3.6	54	5	9
14650	Richard Redell	Stony Stratford	24sh	17	11	8
24000	Edward West	Dunsanger	30sh	36	0	0
2000	Richard Snag	Tottenham	£1. 4.0	2	8	0
12600	John Bailly	Bletchley	£1.11.11	20	2	0
<i>In all 99,450. Rubbing Bricks burnt in Kilnes cost</i>				<i>£130.7.5d</i>		
1,140,300 Total of all Bricks.						
Extras. Including £10 Filling Pits at Norden. Building a Kiln £20. &c.				£69	12	11
				Total	£969	17 9
<i>Note. The carriage of Bricks, 95,53,50 (the rest being included in the price, Cost £81.3.3 about 1sh 8¹/₂d per M).</i>				£ 83	3	3
				Total	£1051	1 0
The conclusion is worked out that ordinary Bricks came to 17sh 5 ¹ / ₄ per M and Rubbing Bricks to £1.8.10 ¹ / ₄ when all charges are included.						

This provides yet more proof of the practice of using locally produced bricks, with the 99,450 standard-sized rubbing bricks purchased for Winslow Hall all being obtained from brickyards within seven miles of Winslow. Also, it shows how important it is not to misunderstand Moxon who writes (1703, 239):

But the best Earth that we have in England for making of Bricks, is in the County of Kent, from whence we have most of the Bricks which are Rubbed and Hewed for the Ornaments of the chief Fronts in the City of London....

He correctly states that best rubbers were to be had by being picked-out from amongst good-quality brick. It is frequently incorrectly stated and recorded (Lamb and Shepherd, 1996, 68) that true red rubbers are a unique blend of brickearth confined to Berkshire and Kent. This is simply not correct. These counties (like Moxon's Kent) were mentioned in seventeenth-and-eighteenth century documents because of their close proximity and ability to transport - by sea and river - bricks into London

Moore (1996, 14) reveals how two loads of 'Rubbing Bricke' were delivered for the enrichments of Coughton Court (Warwickshire) from Worcester by horse and cart in July and September 1665 (a distance of 18 miles), as the coal-fuelled clamped bricks produced locally were not of sufficient quality. Hughes (1994, 107), quoting Surbey's diary entry for work in Nottingham on Monday, 29th May 1699, writes 'Bricks are 12s 6d per thousand delivered, very good and will rub. Carriage is here excluded.'

In essence, both brickearth and clays of varying quality, sufficient to make rubbers, exists over various areas of England. They are, however, no longer exploited as they once were.

For the building of Marlborough House in London (1709-11) including gauged work with large niches, the bricks were imported (The Wren Society, Bolton and Hendry, Volume VII, 1934, 227):

Dutch bricks were used in the construction of the house, rather smaller than those made in England, redder in colour and cheaper, being brought in as ballast in hired transports then coming and going between Holland and Deptford.

2.3.2 The City Bricklayers

The brickwork of the century from 1660 is considered (Lynch, 1994, 44-45):

...by many authorities to be some of the finest artistic and skilful achievements in the world. Bricklayers, especially those in London where the centre of commercial and social activity lay, were keen to be recognised as intelligent, articulate and highly skilled. They had to be conversant with and able to reproduce the latest architectural fashions and craft practices.

The influence of classical architecture and the popular use of brick in the city in the refined manner of the Dutch were central to the acceptance and subsequent prolific use of gauged brickwork from this period. The traditional practice on some principal elevations of colour washing and pencilling joints did not fully reduce the impact of the many busy units. A better, though expensive, solution was to use colour-matched bricks, 'baked' rather than 'burned', and easily cut and rubbed to precise shape and dimensions - rubbing bricks. These could be accurately prepared for setting by dipping into a screened mortar of lime putty:fine sand with joints frequently of 3 mm or less in width thus allowing the classical detailing to be displayed from a broad facade.

From now on, therefore, one begins to see less references to 'hewn' brick, and more to bricks that are to be 'ground' and/or 'gauged', such as at Pembroke College, Cambridge, where in a contract for the brickwork of the chapel dated 16th May 1663, Clarke (1886, 155) records:

...and that the Heads and sides of all the bricks w^{ch} shall appear outwards shall be all ground, and fine ioynts [joints] made.

The ultimate aim of presenting the brick enrichment or ashlar facade with a smooth, rubbed surface of carefully ground, and colour-matched gauged rubbing bricks, was to de-materialise the outside appearance by reducing the joint widths to almost zero. This not only homogenised the overall surface, but also created precision in preparation and presentation of plain and enriched works of finely-jointed masonry that was an integral part of the rich Renaissance/classical heritage.

Gauged brickwork was, and remains, the ultimate refinement and expression of the bricklayer's craft, with setting out, cutting and abrading to shape, and setting and finishing the brickwork to a very high degree of precision. This was an essential requirement in late seventeenth century England, where face brickwork was to be employed so that the classical articulation of the structure might be displayed from a broad, smooth façade, and not visually distracted by the 'busy' effect of many warped bricks and thick mortar joints.

The Great Fire of London in 1666 caused extreme destruction, destroying the timber-built medieval city. The ashes were barely cold when Charles II issued a Royal Proclamation, consolidated by the Building Act of 8th May 1667, which ordained:

And that they [the Surveyors] do encourage and give directions to all Builders for ornament sake, that the Ornaments and projections of the Front-Buildings to be rubbed Bricks: and that all the naked part of the walls may be done of rough Bricks neatly wrought, or all rubbed....

The use of fine rubbed brickwork detailing was clearly highly regarded and seen as an integral part of the better bricklayer's range of skills, thus allowing it to be specified for the enrichments of the proposed new properties.

The knowledge of Dutch craft practices and their materials was clearly being propagated through deeply-read leading architects and close friends like May, Pratt, Hooke and, of course, Wren. Ideas would have been discussed at great length with the best of the city master bricklayers who were also well read to help achieve the degree of enrichment and level of refinement required. Certainly Moxon's writings on the work of the city bricklayer, effectively a seventeenth-century manual on brickwork, reveal how essential craft knowledge, skill in setting out geometry, and working post-fired bricks was considered to be.

Despite high levels of skills, contemporary craftsmen were not being as fully trained as their foreign counterparts, which was itself the subject of some concern (Beard, 1981, 11):

In a long statement in *An Account of Architects and Architecture* which John Evelyn appended in 1664 to his translation of *Freart's Parallele de L'Architecture*, he wrote that he thought English 'mechanicks' impatient at being directed and unwilling to recognise failure, there was a current arrogance, he thought, which implied that craftsmen were unwilling to be taught their trade further when they had served an apprenticeship and worked for gentleman who were satisfied with their endeavours. He did admit that our craftsmen were capable of exceeding 'even the most exquisite of other countries' when they set their minds to it

This was still of concern 30 years later (Beard, 1981, 120):

The humbler abilities of the majority of craftsmen were pin-pointed by Sir Christopher Wren. Writing in 1694 to the Treasurer of Christ's Hospital, he indicated the fundamental weakness in English training; what was wrong was the lack of education in designing or drawing. Craftsmen were capable of copying a foreign pattern so well that often they exceeded the original, but they could not measure against the common training, which everybody in Italy, France and the Low Countries pretends to more or less.

Despite these criticisms, it is freely admitted that native craftsmen in England were undeniably capable of following foreign designs within their own trade and matching, if not excelling, quality of execution. The sheer proliferation of gauged brickwork being used on English brick buildings by the 1670s tells us clearly that the native bricklayers accepted new levels of precision and quickly became supremely confident in the

highest standards of its use. So much so, that the use of gauged work was fully absorbed into the repertoire of a good bricklayer's craft skills, and its use became prolific.

It is an irony that the hugely increased volume of work using brick for re-building the area of the city destroyed by the Great Fire of 1666, should have brought disaster to the Tylers and Bricklayers Company controlling the craft. 'Freemen' bricklayers were hopelessly inadequate in numbers to tackle the job of reconstruction, yet company rules excluded craftsmen from the provinces (or 'foreigners' as they were referred to). Parliament dealt quickly with this matter by decreeing, in the Re-Building Act of 1667, that all craftsmen who were not freemen of the city would, upon being set to reconstruction work, be entitled to the same privileges and 'enjoy the same liberty to work as freemen of the said City for and during their natural lives...'.

Craftsmen flocked from the provinces to London to secure work under state protection. The Company was active in examining 'journeymen' for evidence of apprenticeships in distant towns, to ensure they were proficient and to prevent them working in any other trade.

An outcome of the enforced union of city and foreign bricklayers in the 1660s was the adoption of the high skills displayed in gauged brickwork and some pointing styles. At a time when news and fashions normally travelled slowly, these sophisticated techniques spread rapidly across the country when the foreign bricklayers returned home, enriching the craft nationally. This trend, along with the fact that there was a tradition for country boy's being apprenticed in the city (Webb, 1996, vii) helped to pave the way for the building practices of the following Georgian period.

The return to the native shires of some of these bricklayers can only have helped spread nationally and rapidly the knowledge and skills of gauged brickwork beyond the closed confines of the Bricklayer's Company in London; though one must also acknowledge Moxon's pioneering publications, *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work* (1703).

Some discontented freemen-bricklayers emigrated to the American colonies in the late seventeenth-century, mainly because of a large slump in activity following the boom years. They took with them their traditions, skills and styles to states such as Maryland

and Virginia, where a tradition for fine brickwork grew up (Barksdale Maynard, 2000, 32). They also founded American branches of the livery companies.

This dramatic change in the design and detailing of English brick buildings is most noticeable within a 50 to 60 mile radius of the city, especially from the 1690s. This can be seen in both country and town residences of the wealthy and rising new breed of middle-class merchants. One need only look to such properties as, Aspley House, Aspley Guise, (Bedfordshire) (1692), Winslow Hall, Winslow (Buckinghamshire) (1699-1702); The Grange, Farnham, (Surrey) (1702); Pallant House, Chichester (Sussex) (c.1713); and, at the dawn of the Georgian period, Bradbourne, Larkfield (Kent) (1714). Brunskill and Clifton-Taylor (1977, 32-33) in describing the fine brickwork of Pallant House, suggest that:

...not only are the window-heads exquisitely gauged and provided with a carved emblem on every key-block, but... cut back at their base in delicately recessed curves....

Lloyd (1925, 216) describes most eloquently the ornamental gauged brickwork of the east wing of Bradbourne:

.... The dressings are bright red bricks gauged. The pilasters are built of buff stocks with bright red bricks at the angles; all gauged and only one course in six bonds with the wallings.

The differences in gauging of rubbed work to the adjoining standard facework, (Figure 35) is the manifestation of the problem Pratt (below) pondered. With almost all bricks moulded to the same size, once rubbers were abraded, cut, and set with the tight joint for gauged work it could not be maintained to a complementary gauge with the standard face work laid with nominal joints throughout the height of the structure.

The nation's long and deep affection for brickwork and the emergence of the popular classicist style of architecture facilitated a rapid acceptance of Dutch-styled gauged brickwork at all levels of design and use. The flowering of science, the arts and of craftsmanship of the highest order characterises post-Restoration England, and gauged work, within the art of the bricklayer, simply embodied the spirit of that age. Charles II was patron of the Royal Society, formed in 1660 for improving national knowledge at a time when science pervaded everything, including architecture. The nation began to take a re-newed pride in itself, emerging as a world leader with London, and not Amsterdam, at its centre.

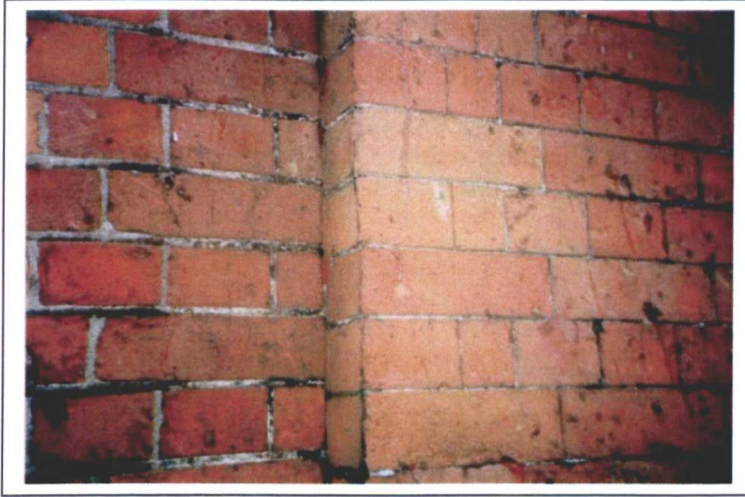


Figure 35 The difference in the vertical gauge of standard to ashlar gauged work, 8 Market Place, Woburn (Bedfordshire), c.1720.

In examining the acceptance and correct use of gauged brickwork and how the associated knowledge and skills were disseminated, it is important to obtain an overview of four key architects. The Royal Office of Works was reconstituted by Charles II at the Restoration in 1660, when the King granted positions to those who had served him in exile. These were Sir Hugh May (1621-84), Sir Roger Pratt (1620-85), and later Sir Christopher Wren (1632-1723), and Dr Robert Hooke (1635-1703). These men were scholars, travelled and well read, and greatly influenced by the fashionable continental designs and craft practices expounded in the pattern and design books that were coming into England from Europe, particularly the Netherlands. They were also closely associated with each other socially and professionally, and with the influential master bricklayers in the city. Documents, accounts, and diaries of these men show them to have been frequently meeting and dining with the master craftsmen and discussing proposed and current projects.

Sir Hugh May

The architect Sir Hugh May (1621-84) stayed in Holland in the service of the second Duke of Buckingham in the 1650s. He was considered to be the only Restoration architect to fully understand the accord between interior planning and external form in the Dutch Classicists style, and that his use of brick and stone was very much in the Dutch tradition. Kuyper (1980, 118-20) says of Hugh May that:

His Eltham Lodge, Kent was built in 1663-5, shows complete sympathy with and understanding of the ideas expressed by Van Campen and Van 's-Gravesande thirty years earlier. In fact it was not the Mauritshuis - as generally accepted - but Van 's-Gravesande's 'Sebastiaandoelen' which provided a model for Eltham Lodge.

Colvin (1995, 647), praising May's ability and significance, suggests:

But of his importance as one of the two or three men who determined the character of English domestic architecture after the Restoration there can be no doubt...

In advising on the conservation and repair of two huge gate piers of gauged work in the walled gardens of Chiswick Park, London, in 1993, the author discovered a previously unknown connection with Sir Hugh May.

The two piers (Figure 36) are 1.2 m square and 4.1 m high, and of gauged brickwork laid to a very high standard of accuracy and refinement with moulded limestone plinth, scrolled console, and capping; all very Dutch in design.

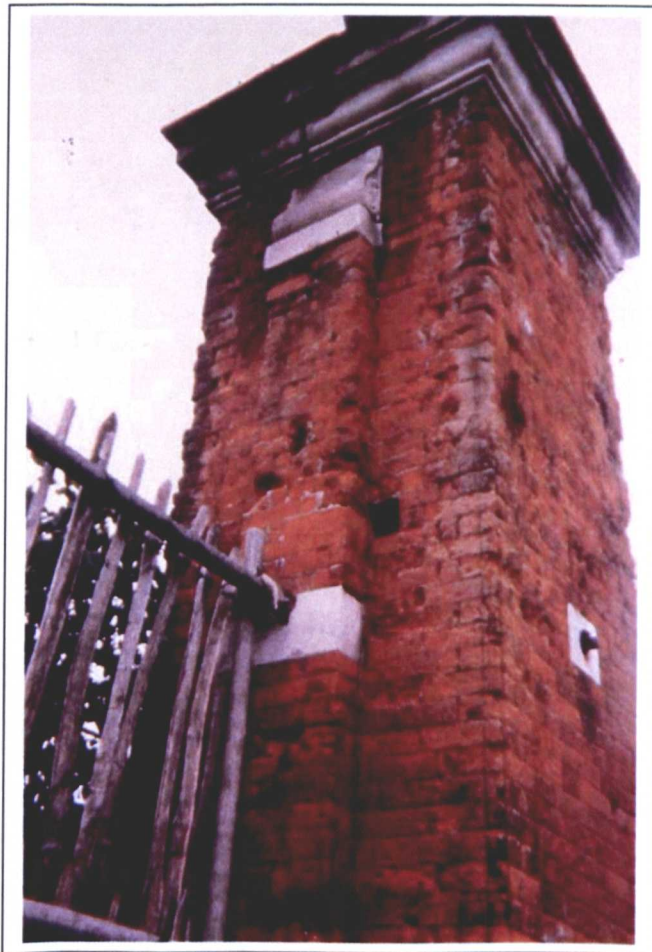


Figure 36 Gauged piers in the gardens of Chiswick Park, London, 1682-84.

The ashlarred orange rubbing bricks have been laid to Flemish bond (as an outer half-brick casing around a stock brick core), and with joints averaging 1mm in with mop-stick (or staff) moulded quoins. (Figure 37).

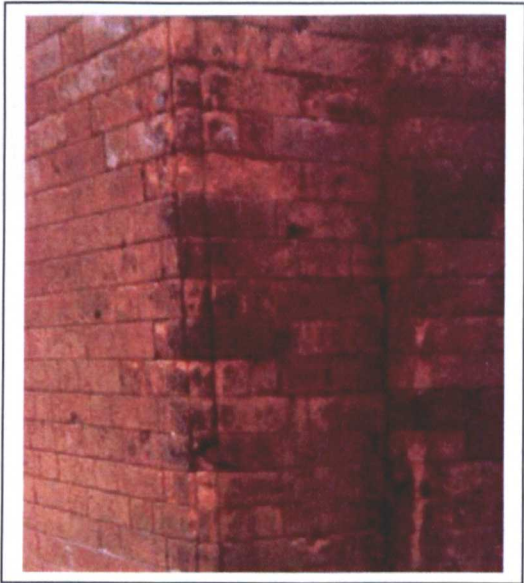


Figure 37 Mop-stick detailing to the gauged pier, Chiswick Park, London, 1682-84.

Colvin (1995, 647) recording a contemporary observation by John Aubrey, suggests:

Twas Mr Hugh May that brought in the staff-moulding on solid right angles, after the Restauration of the king. The fashion has taken much.

Brayley, Brewer and Nightingale (1815, 73) mention the property as:

A copy hold house with two acres of garden was sold in 1663 by Henry Broad a Chiswick resident in 1664 to Sir Stephen Fox, who between 1682 and 1684 replaced it with a house designed by Hugh May, Comptroller of the King's Works....

The house was pulled down in 1812 and the grounds were added to Chiswick House. By studying a print from Brayley, Brewer and Nightingale (1815, 73) (Figure 38), we see an Anglo-Dutch styled brick house with stone dressings that would most certainly have linked constructionally and aesthetically with these piers.

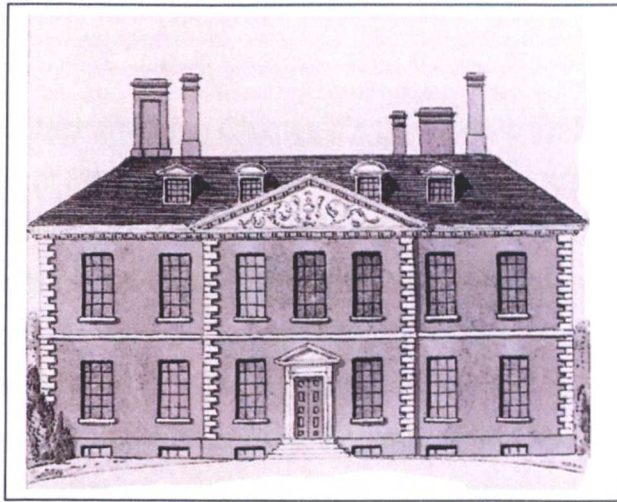


Figure 38 Print taken from A History of Middlesex of Sir Stephen Fox's house, designed by Sir Hugh May, 1682-84.

Sir Stephen Fox (1627-1716) is himself of interest with regard to the links with the master craftsmen and designers who used gauged work. He was a Treasury Commissioner and had been Paymaster General from 1661-79 and continued to control army finance after that period, hence his involvement with Wren on the Royal Hospital at Chelsea, London (1682-84) of which he was a benefactor. He became a very wealthy man with a personal fortune of £200,000, of which the diarist Evelyn (Dobson, 1906, 56), records, that his fortune was '.... honestly got and unenvied...', hence he could afford the very best brickwork and craftsmen for his house. It is likely that he employed the master bricklayer Edward Helder, as the above piers are very similar in design and appearance to the much smaller gauged gate piers, with limestone dressings, at the church and almshouses in Fox's birthplace of Farley (Wiltshire) (Figure 39). Helder erected these buildings in 1680-82, as Fox's benevolent gift to his native community.



Figure 39 Gauged gate piers to Farley churchyard (Wiltshire), 1680-82, (Adrian Feltham).

Sir Roger Pratt

Sir Roger Pratt, architect and King Charles II's Commissioner for the re-building of London after the Great Fire of 1666, had travelled widely in Italy, France, and the Netherlands. Very aware of the rapidly changing architectural fashions and craft practices of Europe in the second quarter of the seventeenth century, he assimilated many ideas leading to a personal style of classicism. The property at Kingston Lacy (Dorset) (1663-5) is Dutch in design and uses brick with stone dressings. Pratt's own notebooks, provide a good insight into the thoughts of this knowledgeable seventeenth-century designer, revealing his ruminations over the preparation of rubbed brickwork. Gunther (1928, 228; citing a memo by Pratt, of 12 March 1669), shows an early use of the word 'gauged' in connection with cut and rubbed work:

What qualities must brick have which will be fit to be rubbed, on what parts is it grinded, how to be gauged. How many rubbed by the day and at what rates

Clearly Pratt is analysing what constitutes a rubbing brick, how it is to be prepared, and the cost of producing bricks ready for cutting to ashlar or moulded enrichments on gauged brickwork. He worries about the quality of a brick for rubbing, particularly the gritty lime inclusions, unwanted as hard inclusions inhibit abrading, and because firing creates reactive quicklime that can cause damaging expansive slaking action upon contact with water (Gunther, 1928, 228):

Regarding brick bonding, Pratt, still writing in 1669, talks of either English (old Roman) or Flemish bond, giving contemporary prices enabling a comparison of the cost of expensive gauged work to standard facework (Gunther, 1928, 230):

This work is either set as the brick comes rough from the kiln and by London workmen in houses wrought at 30/- per rod at the lowest, to 33/-, counted a rate indifference, and in garden walls at 25/-. Or when the brick is grinded; and gauged on all sides, save only that which lies to the brick behind it, at between 45/- at the cheapest, to 50/-.

Pratt reveals how skilled labour is used to rub and gauge (size) ashlar units on upper and lower beds, the stretcher face, and either header, at 90° to them; only the rear face abutting the common back-up brickwork is not touched. He comments on the quality of rubbers used and the highly-skilled labour to prepare and set gauged work made the work around 50 per cent more expensive than standard front brickwork.

In writing on practical considerations of gauged brickwork in his notebook for February 1666 Pratt records (Gunther, 1928, 232):

That in all rubbed work where the bricks are to be exactly ground and gauged and so to be made thinner than those on the inside of the walls, that care be taken that they may be wrought up together with the inside and so have good bond with it, and that the white joint to be no more than a quarter of an inch only, and that the inside of the walls be very well filled whether with mortar at the first, or with hot lime afterwards.

To this end the rubbing bricks at the first should be made somewhat thicker than the unrubbed

Ashlared gauged work was not only reserved for platt bands and aprons, but (for those who could afford it) whole fronts in the post-Restoration period. Usually set with a larger bed joint of about 5 mm thick, and 2-3 mm wide for perpends. These were generally jointed with a 'struck and sometimes 'ruled' profile., as can be seen at Wren's work at Hampton Court Palace (Figure 40). Pratt reveals his concern for the problems arising from rubbing bricks being the same size as standard bricks. Once rubbed, gauged and set on a finer joint, the outer half-brick facade would immediately fall out of continuous vertical gauge with the backing brickwork, leading to the question of how best to reconcile and tie the two leaves together.



Figure 40 Ashlared gauged work at Hampton Court Palace, London, 1690.

There can be little doubt that this is how the later common practice of Georgian 'facadism' took root; though by then it involved first-quality face brickwork and not gauged work on the outer leaf. Flemish bond was popular for gauged work due to the reduction in headers that could be snapped in two thus, for economy, gaining two expensive header face bricks instead of one. Tying-in the half-brick facade with full headers was only practised on an occasional basis. This practice used primarily with

Flemish bond, which could lead to the facade brickwork separating from the backing brickwork, was of concern.

Pratt's solution was twofold. Increase the size of a brick for use as a rubber over the standard gauge to facilitate rubbing, cutting, and thin jointing in order to maintain coursing with the standard walling set in nominal sized mortar beds. Also, to ensure the linear 'collar-joint' between the two skins of facade and backing brickwork was made solid either as work progressed or by grouting to make up for the lack of full or through headers.

Dr Robert Hooke

Dr Robert Hooke, English chemist and physicist was also a respected architect and friend of Sir Christopher Wren. He designed and supervised the building of a number of London's new churches, putting him in contact with many of the leading craftsmen as his diary of 1672-80 records. He certainly met Edward Helder, master bricklayer, at the very time he built the fine masterpiece of gauged brickwork for his own house in Enfield (1675) this now stands in the Victoria and Albert Museum (Figures 41 and 42).

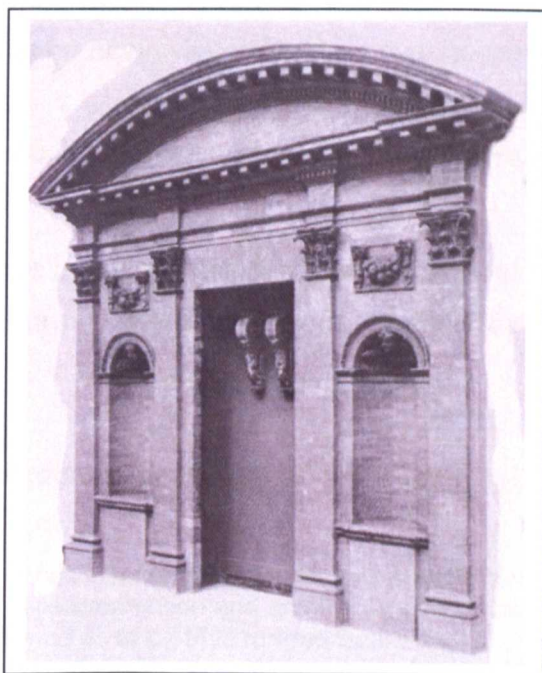


Figure 41 Helder's masterpiece of gauged brickwork, 1675, now in the Victoria and Albert Museum, London (by courtesy of the Board of Trustees of the Victoria and Albert Museum).



Figure 42 Print of Helder's house, Enfield (Middlesex) from Pam's A History of Enfield, 1675, showing the gauged frontispiece.

Hooke's diary entry for Thursday 23rd September 1675, records, '...viewed Helder's building' (Robinson and Adams, 1968, 182). The entry for Monday 27th September 1675 appears to confirm that he again visited Helder's own house during its construction:

... View at Helders, Dougate... Discoursed with Rider, Gumbledon, Gooday, Tooley, Scarborough, Helder.

He must therefore have been very aware of the fine skills of gauged brickwork that was displayed on Helder's own property and discussed materials and relevant constructional techniques with him.

As Kuyper (1980, 116) states:

Hooke's interest in Dutch science and architecture is well known. In his diary there are many references to... town-reconstruction and architecture. In December 1672 Hooke started to learn Dutch, evidently so as to be able to read Dutch books, of which he mentions several on diverse subjects. His entry on Mr Story describing to him the recently completed churches in Amsterdam in 1674, is well known. There are in addition some indications that he visited Holland shortly before 1672

Sir Christopher Wren

Sir Christopher Wren was a distinguished mathematician as well as a professor of astronomy and architecture:

Sir Christopher Wren made himself into a great architect. He had no formal training and little opportunity of knowing, at first hand, the architecture of the Continent of his own or any other age. He built nothing before he was thirty; but by the time he was seventy and still very active, he could rival any European architect then living. (Whinney, 1971, 7)

As to continental influences Kuyper (1980, 121-2) remarks:

...Pratt and May, fused the different sources into a consistent style of their own, whereas the more enquiring, probing scientific mind of Wren tried from time to time to assimilate various complete facade schemes into his vast complexes.

Wren was quite likely to seek out the advice of these respected architects and friends, especially on points of detailing and manipulation of materials this is particularly so with brick (an essential masonry material in the city), with a precise refinement important and attractive to Wren's taste.

Some of Wren's buildings, such as Tring Manor (Buckinghamshire) (1670) and the Royal Hospital at Chelsea, London (1682-91) do recall massing and detailing in the combination of brick and stone as seen in Dutch work (Kuyper, 1980, 122-3).

Following the Great Fire of London, it was to Wren, appointed Surveyor General in 1661, to whom the task of re-building elements of the capital fell, an opportunity unique in the annals of architecture. Over 13,000 houses and 87 churches had been destroyed. Wren was to build 30 of the latter and a number of other prestigious properties; though his crowning glory was St Paul's Cathedral (c.1675-1711). Wren was fortunate in having the assistance of a most gifted architect assistant, Nicholas Hawksmoor (1661-1736), and some of the greatest craftsmen in England, as well as Europe, gathered in the metropolis who had a thorough understanding of their craft. These included Grinling Gibbons (wood carver), Caius Gabriel Cibber (stone carver and sculptor), Jean Tijou (blacksmith), and Peter Mills, Maurice Emmett and Edward Helder (master bricklayers). Wren was also very fortunate to have his chief assistant, Nicholas Hawksmoor (1661-1736) from the late 1670s, whose natural architectural talent stimulated and brought out the very best of Wren.

Wren employed constructional materials in a manner that maximised their benefits architecturally (Lloyd, 1925, 61-62):

In the Fountain Court at Hampton Court Palace, finely jointed, rubbed, red brickwork is associated with the light and dark of moulded and richly carved Portland stone, producing the gayest effect. Such use of brick by Wren has been well described by Professor C. H. Reilly (when referring to the entrance to Middle Temple), in the following words:

'The main wall face between the pilasters is in red brick, ...He has done it by a method of which he was very fond; witness parts of Hampton Court, by using very small - about 6 inches by 2 inches, instead of the ordinary 9 inch by 3 inches - soft rubbed bricks, which can be carved like cheese and yet stand the London atmosphere.

Although Wren achieved wonderful ashlar gauged work at Hampton Court Palace, research has revealed that it is incorrect to attribute the design of the entrance of the Middle Temple to Wren. The architect was Roger North (1653-1734) who built the Great Gateway in 1683-4.

Roger North

Roger North (1653-1734) was a lawyer with the middle temple, writer and member of the Royal Society, he was in touch with the intellectual and scientific ideas of his time he was also a gentleman architect, and a friend of May and Pratt. His treatise *Of Building*, on the re-building of his own home at Rougham Hall (Norfolk) is considered 'probably the most detailed account of the planning and building of a seventeenth-century house in English architectural literature' (Colvin and Newman, 1981, xix-xx).

It was Roger North who designed the Great Gateway which still gives access to the Temple from Fleet Street and of his design for the gateway, North himself writes (Colvin and Newman, 1981, 51):

... I was forc't upon such expedients in building the Middle Temple Gate: I designed 4 pilaster columnes and a fron tone [pediment],...and then grounded the wall with brick, rubb'd and gaged, which sett off the stone. [The master mason was John Shorthose and the master bricklayer Joseph Lem].

2.3.3 Influential City Master Bricklayers

All the influential city master bricklayers displayed excellence in the use of fine brick enrichments. Whilst Peter Mills has already been discussed (section 2.2.4), it is important also to study two further individuals, Maurice Emmett and Edward Helder. In

order to understand how the skills and use of gauged brickwork were being used, passed on, and subsequently proliferating at the highest level during this period.

Maurice Emmett

Maurice Emmett (also spelt Morris Emmott) (1646-94) was born in London and apprenticed to his father, Maurice Emmett, Snr., who had briefly held the post of master bricklayer in the Office of Works in 1660. The younger Maurice Emmett held the office of Master Bricklayer in the Office of Works from 1677 until his death in November 1694.

Colvin (1995, 347) states:

As a master bricklayer Emmett was employed at Chelsea Hospital from 1682, at Winchester Palace 1683-4, at Windsor Castle in 1685-6, at Whitehall in 1685-7, and at Kensington Palace in 1689-90.

On most of these aforementioned buildings are examples of the skilled gauged work of Emmett, his younger brother George, cousin Stephen, and many of his team of craftsmen. Of interest is the specimen of an account supplied for brickwork at Hampton Court Palace by Emmett for Sir Christopher Wren (The Wren Society, Bolton and Hendry, 1927, Volume IV, 45) . Here, as was standard practice, the 'gaged' work is itemised separately from general brickwork or, in the seventeenth century parlance, as 'over and above':

For work measured from the bottom of the water table to bottom of the first floor, together with the foundation of additional walls and chimneys and 2 wells in the Parke Garden	£	sh.	d.
For 148 Rodd of new brickwork reduced to brick & a half in thickness	192	8	0
For 850 ft 10 in of rubbed and gaged work over windows and doors	28	7	3
For 61 ft 4 in of coins rubbed and gaged	1	10	8
For 6 neeches each 9.0 and 4 ft wide at £2 each	12	0	0
For 70 ft of arch 7 brick and half	2	3	9
For 48 ft of arch 5 brick	1	0	0
For 100 ft of arch 4½ brick	1	17	6
For 22 ft of arch 4 brick	0	7	4
For 40 ft of arch 3½ brick	0	11	8
For 191 ft of arch 2 brick	0	11	10
For 162 ft of arch 1½	0	12	9

Emmett's gauged work at Hampton Court Palace, as at his other buildings, echoes in appearance and quality the early contemporary Dutch masterpieces of the

metselaargildekamer in Amsterdam, and in particular the manner of how he constructs his brick niches (Figures 43 and 44).

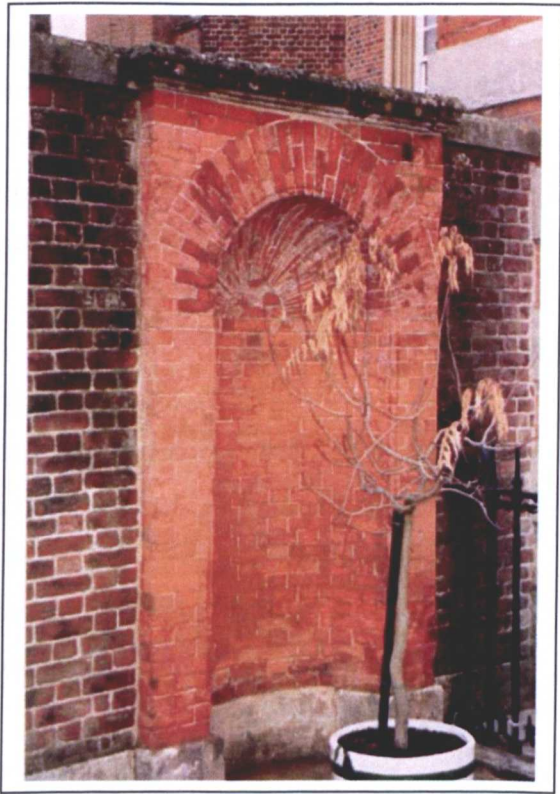


Figure 43 One of Emmett's original niches at Hampton Court Palace, London, 1690.



Figure 44 Set of three gauged niches by Emmett at Hampton Court Palace, London, 1690.

Edward Helder

The surname of Edward Helder (Holder or Elder) is highly suggestive of Netherlandish extraction, and communication with the Low Countries substantiates this. Genealogical researcher Victor Longhorn (2004) indicates that Helder may have been born in Hitchin in 1640, and that there had been a large influx of refugees (including Helders) from the Netherlands to that area in c.1584-5. Edward Helder wrote his will on 14th June 1683 and soon afterwards he died.

That he was a master bricklayer of the highest level is beyond dispute. Wren and many of his eminent colleagues employed him on various major projects. Among the more notable were:

- St Antholin, Watling Street, (1678-82)
- The Temple Bar (1672) (Removed in 1878 and set up at the entrance to 'Theobalds Park', near Cheshunt, in Hertfordshire in 1888);
- The Church and Almshouses, Farley (Wiltshire) (1680-82)
- Christ's Church, Newgate Street (1677-87)
- Christ's Hospital, Newgate Street in London (c. 1682-84)

Of particular significance, Helder constructed his own magnificent house at Enfield in 1675, which later became the Cowden Clarke Schoolhouse. It has been discovered that it was on this property that Helder chose to display his supreme mastery by building the exquisite pedimented window opening of fine gauged brickwork that can now be seen in the Victoria and Albert Museum. Charles, the schoolmaster's son (Pam, 1990, 148) described as follows:

The structure was of rich red brick moulded into designs decorating the front with garlands of flowers and pomegranates, together with the heads of cherubim over two niches in the centre of the building.

... it was demolished in 1872, it was taken down brick by brick, with the greatest care, each being numbered and packed in boxes of sawdust for carriage. Nothing could exceed the beauty of the workmanship, the bricks having been ground down to a perfect face and joined with beeswax and resin, no mortar or lime being used.

The beeswax and resin mix is part of an old mason's mix mentioned at Kirby Muxloe in April 1483 (Hamilton-Thompson, 1920, 270), as:

... 1lb. Wax, and 2lb Rosen, for syment [cement] to be made therefrom for le ffremasons.

This was a recipe for bricklayers cementing a block, or 'lump' of prepared bricks to withstand vibration and abrasion in the carving of capitals, scrolls and cartouches (Moxon, 1703, 286-7).

Reading Pam's account can give an incorrect impression that the entire gauged edifice was constructed in this mix, when it was only the elements to be carved. The rest of the gauged edifice was set in standard lime putty: silver sand mortar; hence the slightly thicker joint size that is clearly visible. (Figure 45).



Figure 45 A carved gauged Corinthian Capital to a pilaster, The Victorian and Albert Museum, London, 1675 (by courtesy of the Board of Trustees, Victoria and Albert Museum).

Pam (1990, 148) concludes:

.... In this manner the whole front was built in a solid block, the circular niches with their carved cherubs being afterwards cut out with a chisel.

Whitaker (1911, 206), describing this masterpiece, says:

... Nothing could exceed the beauty of the workmanship The similarity of its elevation to that of Temple Bar cannot but strike the most inattentive observer, and the arched recesses and their enrichments recall the beautiful blank windows towards the western end of St Paul's Cathedral.

Certain constructional aspects of the magnificent gauged frontispiece to the chapel at Christ's Hospital School (The Bluecoat School) in Horsham (Sussex) are similar to the above masterpiece. Originally erected in 1672 in Newgate Street, London, where Helder

certainly worked in the 1670s and 1680s. The design Lloyd (1925, 96) attributes to Wren, who along with Hooke, was a Governor of the school (Figure 46).

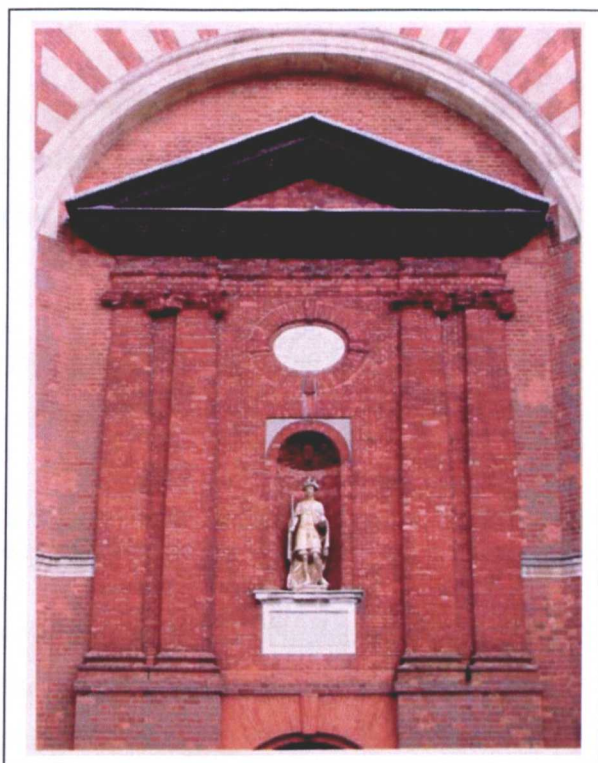


Figure 46 Gauged frontispiece, c. 1672, at Christ's Hospital School, Horsham, Sussex, (Mark Haskell).

This frontispiece was carefully disassembled and re-erected, when the school moved from the city to its present site in 1901. (Bryant, 1902) records:

On the south end of the building (Old School) there is a very interesting piece of brickwork and a statue of Edward VI. This brickwork came down in little wooden boxes about a foot [305 mm] square and numbered and it was rebuilt here exactly the same as in London.

The whole edifice, from first-floor level up, is of ashlar gauged work with delightfully textured orange-red rubbers. Of particular interest are the Ionic capitals to the four engaged pilasters with entasis, and the hood of the central niche, all of which have been formed of courses of ashlar gauged work, set to bond, in either hot or cold cement to form lumps and then carved. Again, the fineness of their joints compared to the surrounding gauged work is readily apparent.

Of interest are the seventeenth-century red rubbers, with their inherent texture and visible inclusions so typical of this period, compared to the 1902 gauged arch of the entrance doorway directly below, constructed of Edwardian, washed and clean-bodied TLB orange-coloured rubbers. It is an example of how the latter class of rubbers,

though of first class quality and universally copied today by the present brickmakers, is so often an imperfect match for rubbing bricks on gauged work dating from before the mid-nineteenth century.

The complexity, quality, and style of execution of several gauged entrance frontispieces to the doorways of the chambers in King's Bench Walk (1678), formerly attributed to Sir Christopher Wren, suggests that there may also be the work of Edward Helder and his team of bricklayers.

Correspondence with Dr C.M. Rider, archivist for The Honourable Society of the Inner Temple (Rider, 1998), reveals:

.... archives do not contain any original drawings of the doorways and there is little detailed information about their construction.

The original chambers were destroyed in the fire of 1666 and the tenants were eventually allowed to build again after certificates were 'read' by Peter Mills, Richard Kirby, and Sir Christopher Wren on 27th April 1670.

Rider emphasises:

...the newly constructed chambers in King's Bench Walk had to be rebuilt in 1678 after another fire in 1677.

Hooke also records this fire (Robinson and Adams, 1968, 316):

Friday, September 28th 1677, - fire at the temple, rose at 3, went to it. It consumed all the Kings bench building....

Rider concludes:

The fact that most of the building works were commissioned by the tenants rather than by the Inn itself explains the lack of information in the Inner Temple archives.... Presumably the building accounts and invoices etc, were retained by the tenants and are now lost. There is no evidence of any involvement by Sir Christopher Wren in the 1678 building.

This final point is of great importance, as Wren is often documented as the architect (such as by Lloyd, 1925, 277-79) yet there is no mention of his involvement in the Kings' Bench Walk doorways in *The Wren Society Volumes*.

Whoever the architect, he would have worked in close co-operation with his master bricklayer (such as Helder or Emmett). He would have gained all of his full-size working templets for every shaped part of each frontispiece from the drawing/s. From the templets, the individual bricks of the entire enrichment could be set out, cut and rubbed, numbered, and dry bonded within the cutting shed for on-site assembly. This combination would have left the frontispieces to be completed under the direction and supervision of the master bricklayer alone.

Study of measured and scaled drawings of these doorways and their details drawn by Ernst V West (Amery, 1974 plates 34-40) enables one to assess the technical superiority of the finely gauged brickwork against that of the pre-Restoration period. At number 5 King's Bench Walk (Figure 47), the orange coloured rubbing bricks are precisely ashlar and rubbed smooth (revealing minor inclusions) measuring $7\frac{3}{4} \times 3\frac{5}{8} \times 2$ ins (197 x 92 x 51 mm).



Figure 47 Fine gauged entrance doorway of 5 King's Bench Walk, London, 1678.

These contrast favourably to the main walling bricks of $8\frac{1}{2} \times 3\frac{3}{4} \times 2\frac{1}{2}$ ins (216 x 95 x 64 mm). The bonding of these frontispieces varies between English and Flemish bonds, with a four course gauge of $8\frac{1}{4}$ in (210 mm), the bed joints averaging $\frac{1}{16}$ in (1.5 mm).

Other influential, leading seventeenth-century city master bricklayers, who worked for Wren, May, Hooke, and Pratt were:

- Tom and John Fitch (Fits, Fitz)
- John and Anthony Tanner
- Thomas Horne (Horn)
- Joseph Lem (Lemme, Lenns)
- Benjamin Leach
- Isaac Corner
- Richard Stacey
- John Yeomans (Yemens)
- Thomas Hues
- Richard Billinghamurst
- Thomas Warren
- John Bridges
- Edward Goodman
- Thomas Harris
- Nicholas Wood

Yeomans was the master bricklayer selected for Winslow Hall (Buckinghamshire) and here we have a valuable insight as to how his gauged work was priced for various architectural applications, through an abstract of payments and allowances in the accounts (Bolton and Hendry, 1927, Volume IV, 65):

ffor Bricklaiers Work			
ffor the Workmanship of 210 Rods 2 Qrts. 64 ⁷⁵ / ₁₀₀ ft	£	s	d
Brickwork at 27sh per Rod	284	9	7
ffor the Ornaments of 118 Windows at 15 sh ea	88	10	0
ffor 2819 ft rubd work at about 6d per ft Sup.	70	9	0
ffor 770 ft rub work in coping of new garden at 4d per ft	12	6	8
ffor cutting 264 ft Groyning at 4d per ft	4	8	0
ffor Workmanship of 2 Ovens	2	0	0
ffor 291 ft rubd and gaged peers with staff moldings at 10d per ft Sup	12	2	6
ffor 9 ¹ / ₂ ft Streight Arch at 10d per ft Sup	0	7	11

Undoubtedly the rising aspirations of the seventeenth-century city bricklayer would have provided added impetus to learning the finer skills of gauged brickwork, thus giving the best masters undoubted parity with the finest stonemasons. It must still be remembered that, despite the rules of the respective guilds, there was no clear separation between the craft of the bricklayer and the stonemason. This was particularly true at the highest levels of the craft, where knowledge and skills were complementary. As in the Netherlands at this time, bricklayers were frequently contracting for work that involved both brick and stone, and the reverse was also true. Evidence to support this can be gleaned from studying the contracts relating to the re-building of the city churches after The Great Fire; here masons such as Cartwright, Fulkes, Marshall, Pearce and the

Strong brothers executed brickwork as well as stonework. This cross-fertilisation of skills and knowledge was particularly important for the development of fine gauged brickwork, at a time when there was a more classical and theoretical approach to architecture.

The essence of this contemporary view of the bricklayer is summed up by Moxon (1703, 237) who says:

Whether the *White Mafon*, which is the *Hewer of Stone*, or the *Red Mafon*, which is the *Hewer of Brick*, be the moft ancient, I know not: but in Holy Writ, we read of making of Bricks before we read of Digging or Hewing of Stones; therefore we may fuppofe the *Red Mafon* (or Bricklayer) to be the moft Ancient.

2.3.4 Joseph Moxon and Mechanick Exercises

Joseph Moxon (1627-91) author and fluent in Dutch, Latin, French and German was one of England's ablest mathematicians, a friend of some of England's greatest seventeenth-century scientists such as Robert Boyle, Edmund Halley and Robert Hooke and a fellow member of the Royal Society.

For those researching the historical development of English brickwork, and in particular gauged brickwork, Moxon's exercise on *The Art of Bricklayers Work*, first published in 1700, provides essential reading. It offers a powerful 'snapshot' of craft skills and knowledge at the close of the post-Restoration period and the dawn of the Georgian period.

Benno M. Forman in his introduction to the facsimile of Moxon's 1703 edition of *Mechanick Exercises* states (Montgomery, 1970, ix-x):

Historically it stands as an iconoclastic work that broke for all time the medieval patterns that had long impeded the progress of the crafts. Moxon's MECHANICK EXERCISES forecast the direction of England's economic development for the next two centuries.

Of particular interest, Forman ruminates why, given the Great Fire of 1666, Joseph Moxon did not produce his treatise on the bricklayer's art earlier when it would have been in huge demand as the city was re-built in brick. Forman (Montgomery, 1970, xviii-xix), argues that there is a stylistic change in the writing from the earlier publications and as Joseph Moxon had died in 1691, this was in fact the work of his son James; hence the commercial decision to market the work as by 'J. Moxon'.

The mention of Venturus Mandey as assisting (Montgomery, 1970, xix) indeed possibly co-authoring with James Moxon, is also of significance as to why Moxon's work on bricklaying is both later and different in its style. Venturus Mandey (1645 -1701), was a city master bricklayer in great demand in the years following the Fire.

The bricklayer, Venturus Mandey... seems to be the Venturus Mandey who produced a book with Joseph Moxon as joint author. If so, Moxon probably got his information regarding bricklayers' work from Mandey. (Lloyd 1925, 77)

2.3.5 *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work*

In his remarkable work, *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work*, Moxon (1703, 237) explains from the start that:

Firft, I will fhew what Materials they ufe and their Compofition,
Secondly, I will treat of their Tools, and defcribe their Names and Ufes,
Thirdly, I will declare their Method of Working, both in *Bricks, Tiles, &c*

In the first part *Of Bricks* we have the first mention of the bricks for rubbing and hewing:

But the beft Earth that we have in *England* for *making of Bricks*, is in the County of *Kent*, from whence we have moft of the *Bricks* which are rubbed and Hewed for the Ornaments of the chief Fronts in the City of *London*: The Ornamental part of which Fronts, are done with the reddeft Bricks they can pick from among them; and the Rough or Plain Work, is done with the *Grey Kentifh Bricks*. (Moxon, 1703, 239)

Moxon reveals the need to bring into the city not only the best bricks for cutting, but for the gauged enrichments to be in the 'reddest bricks', not possible from the mass of London stocks being produced in the capital.

Moxon was also very specific about what type of lime was to be used for all forms of constructional masonry (Moxon, 1703, 241):

There are two forts, one made of Stone, which is the ftrongeft, and the other of Chalk, both forts being burnt in a *kilne*.

The Lime that is made of foft Stone or Chalk is useful for Plaftering of Seelings and Walls within Doors, or on the infides of Houfes; and that which made of hard Stone, is fit for Structures or Buildings, and Plaftering without Doors, or on the out fide of Buildings that lies in the Weather....

Moxon is advocating the use of greystone lime as the principal binder for all bricklaying mortars. Also called water-limes these were capable of an internal set (even below

water) due to their burning characteristics and impurities within them that rendered it reactive during burning to form quicklime. Today, these are termed 'hydraulic'. Pure or chalk limes, Moxon emphasises, are only deemed suitable for internal and non-structural work such as plastering. Then called 'air-limes' (today termed 'non-hydraulic') they were incapable of setting, but instead hardened by absorbing carbon dioxide from the atmosphere; this they could not do below water.

In his second part, 'Tools used in Brick Work'; Moxon lists 23 tools, each with a succinct explanation of their use together with an engraved plate depicting them (Figure 48).

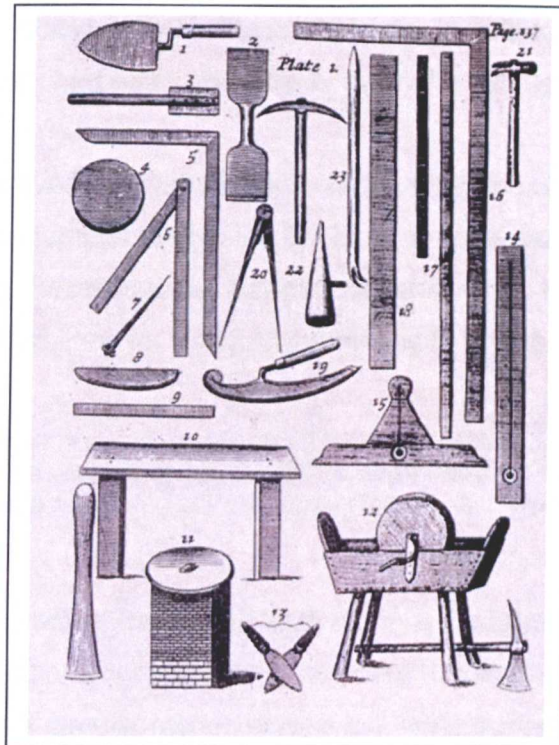


Figure 48 *Moxon's plate 1 depicting tools used by the seventeenth-century bricklayer.

These tools would have been part of the hewer's equipment, kept in the cutting shed where all the setting out and cutting of architectural enrichments took place. Such a place was supplied by Hugh May at Whitehall Palace in 1668:

A shed was built in the Pebble Court for the working of the cut, rubbed and gauged brick. The mouldings were 'hewn' in brick... and two square niches... (Colvin, 1976, 272)

We can determine how much gauged work was being emphasised as a necessary craft skill for the seventeenth-century craftsman bricklayer by extracting the full meaning behind Moxon's descriptions of the tools and how they were to be used (Moxon, 1703, 245-48):

2. A *Brick Ax*, with which they cut *Bricks* to what fhape they pleafe, as fome for Arches both ftreight and Circular, others for the mouldings of Architecture, as Archytrave Friez and Cornice.

The brick axe was, as detailed earlier, the chief cutting or hewing tool. Moxon reveals it was not only for cutting arch voussoirs, but also shaping mouldings for enrichments.

3. A Saw made of Tinn, to faw the Bricks which they cut.

Later termed a 'grub saw', and measuring about 150 mm long 75 mm high with 1-2 mm thick with in-line serrated teeth. Shown as having a long wooden handle fixed to the centre of the saw blade giving two cutting edges, it is possible that one set of teeth were finer than the other. Some older craftsmen still refer to cutting with a grub-saw as 'tinning', or that a brick had been 'tinned' (i.e. ready for cutting to shape).

This tin saw would have been used in three ways. First, to cut a deep (5 mm) line into the bricks around the templet to give the brick axe a good start and preventing spalled arrises when cutting. Second, to cut straight sections. Third, to cut a series of parallel slots above the scribed lines for axing and abrading to profile.

4. A *Rub-ftone*, which is round, and is about fourteen Inches Diameter, and fometimes more of lefs at pleafure, on which they rub the Bricks which they cut into feveral fhapes, and also others which they cut not, being call'd *Rubbed Returns*, and *Rubbed Headers* and *Stretchers*.

Also called a 'rubbing stone', usually of York stone and round on plan although it could be square. It has traditionally been round, as of the rubbing action, used when squaring brick faces is always a circular motion across the stone surface. It is likely that the first rubbing stones were from old grinding-wheels.

Moxon also describes bricks rubbed for cutting and those not being cut. He describes preparing ashlar bricks as 'rubbed returns' for quoins, and as headers and stretchers for the remaining facework. These would be marked to a templet - 'scribed' - and then simply rubbed down to the required size. This, Langley (1749, 286) describes 50 years later:

...of various kinds, viz., Rubed only, and set in Front Mortar; or gaged, rubed and set in Putty. Those which are rubbed only are chiefly the sides or jaumbs of Windows and the external angles or quoins of buildings.

'Front mortar' was the well-screened standard bricklaying mortar reserved for the outer-face of brickwork on principal elevations, as opposed to a generally weaker mortar of crudely slaked lime and coarse sand for 'backing-up' or internal use on the building.

5. A *Square*, to try the bed of the Brick, (viz. That fide which lies in the Morter) with the superficies or face of the Brick, to make the Brick square, or at Rect-angles one fide with the other, which is done by rubbing it on the Rub-ftone till it exactly answers, or fits to the Square.

Craftsmen now use a carpenter's 'try-square', whereas Moxon's plate shows a large iron square, though its use for preparing rubbers remains as Moxon describes. 'Trying', or testing the brick faces after they had been rubbed to ensure they are at 90° to each other is known as 'squaring'.

6. A *Bevel*, by which they cut the underfides of the Bricks, of Arches freight or circular, to such oblique Angles as the Arches require, and also for other Uses.

Also known as a 'sliding-bevel', Moxon wrongly describes it being used to '...cut the underfides of the Bricks, of Arches freight or circular...'.

What he really meant was marking-out and checking rather than actually cutting an arch voussoir; termed 'soffiting'. Some radiating voussoirs meet the arch intrados obliquely so need their undersides, or soffit faces, cut to the required angle. On a 'streight' (flat) arch, apart from the central 'key' brick, all the voussoirs have different soffit bevels, as they become more inclined away from the key to the skewback position.

The bevel would establish and transfer the relevant angles on the setting out or tracing, board to the bricks prior to cutting.

7. A *small Trammel of Iron*, or a large Nail ground'd to a sharp point, with which they mark the Brick, either from a Square or Bevel, or a Mould made of thin Wainfcot, or Palt-board to direct them in the cutting thereof.

A large flat clout nail, ground to a sharp point is now termed a 'scribe'. This is used to score or 'scribe' the outline of any templet prior to 'tinning', if necessary, with the grub-saw and then rubbing or cutting to shape

The small 'Trammel' is possibly also to be used as a bench-mounted trammel with a sharp point, set to the desired radius, to help make the cutting marks for curved work. Trammels would, where necessary, be fitted with a metal-edged reverse (or negative)

templet to serve as a running mould. This facilitates scribing mouldings and checking end 'drafts' as they are worked, but also for turning along the length of the axed brick profile to test/abrade the final few millimetres from it to finish. A variation of a plasterer's 'horse-mould', it was vital for the degree of accuracy gauged work with 1mm joints demands. This technique has been tested by the author and invited craftsmen and works well. Furthermore, not only was it seen and viewed as a logical practice by stonemasons, Peter Hill and Piers Conway, but also master plasterers Arthur Watkins (former Head of Plastering at Luton College) and Jeff Orton (Trumpers Limited). Both have huge experience of *in situ* and bench-run plaster mouldings, and agreed that historically crafts communicated and shared techniques in a manner unheard of today. The technique also accords with Moxon's remarks in the first part of point 8 below.

8. Some use a *Float Stone*, with which they rub the moulding of the Brick, after they have cut it with the Ax, pretty near to the Pattern described on the Brick, by the *Trannel* from the Wainscot, or Paffboard Mould, that fo they may make the Brick exactly to anfwer to the Pattern or Mould. Others ufe no Stone at all, but cut the Brick exactly to the Pattern with their Brick-Ax, leaving the Ax fthroaks to be feen on the Brick, which, if they be freight and parallel one to another, look very prettily, and is the trueft way of Working; but then they muft take care, to Ax the Brick off, with an Ax that is exactly freight on the edge, that the moulding in the Brick be neither round nor hollow, from fide to fide of a Header, or from end to end of a Stretcher.

The 'Float Stone' is traditionally made of York stone, though various grades of carborundum are also employed today. It is a small hand-held stone used for rubbing down completed, surface-dried, work to finish; 'floating' over the face of the work in a circular motion. It varies in size and shape, and the fineness of abrasive. If used on circular work, such as a niche, it must be shaped to the curve.

Stonemason, Piers Conway, suggests craftsmen could have also used a sandstone block carved to the negative, or reverse, profile of the moulding being worked. This would then be used in the cutting shed and for the set work, ensuring an accurate finish (Conway, 2002).

Moxon, in point 8, states that some dress their cut work with the brick axe, while others use the 'float stone' to rub the moulding after they have 'axed' it to answer (fit) to the templet. The latter, by the late seventeenth century, had become, as in the manner of the Dutch, the preferred finishing technique. The vast majority of the gauged work from this period is almost always rubbed smooth, which could also account for the distinct shape of the engraved 'Float stone' in Moxon's plate. It is flat on one face and, on the

opposing side, shaped to fit certain curved mouldings, and/or for the relatively standard sized niches.

Moxon stresses traditional hewing practice was '...leaving the ax froaks to be feen on the Brick, which, if they be freight and parallel one to another, look very prettily, and is the trueft way of Working...'. This only appeared neat if the axing marks were straight and parallel one to the other. Moxon's remark that it is, 'the trueft way of Working' is not meant to be disparaging about the 'new' fashion for smooth rubbed surfaces, only to emphasise the pre-eminence of the older 'axing' technique.

Moxon concludes this point with sound advice to prospective 'hewers', irrespective of whether the cut moulding is to be rubbed smooth or not. The brick axe must be 'exactly freight on the edge' or the resultant moulding will cut either concave or convex across the width of the brick face.

9. *A Little Ruler*, about 12 Inches in length, and 1 Inch and ½ broad, which they lay on the Brick to draw freight Lines by, with the *Trannel* or *Nail*.

This passage regarding the Little Ruler is self-explanatory, but worth reproducing as it shows its application in helping to scribe a brick prior to rubbing or cutting. Large measuring rods have a history of use on all masonry, and can be used as described for setting it out, indeed Moxon shows and describes them, as in point 17:

17. *A Ten Foot and a Five Foot Rod*, as alfo a *Two Foot Rule*, to take and lay down Lengths, and Breadths, and Heights.

Gauged work, of the highest quality requires accurate measurement in its execution. The more geometrically complicated and finer the enrichment that is to be constructed, in terms of joint size, the more there is a definite need to measure precisely at each and every stage.

10. *A Banker*, to cut the Bricks upon, which is a piece of Timber about fix foot long, or more, according to the number of thofe who are to work at it, and 9 or 10 Inches fquare, which muft be laid on two Piers of Brick, or fixt on Bearers of Timber about three foot high from the Floor, on which they ftand to work.

The term 'Banker' is a stonemason's term (Hill and David, 1995, 143):

The banker, on which the stone is worked, is traditionally a large block of stone. It should be as heavy as possible, the better to resist any tendency to move as the stone is worked.

The banker described by Moxon is today termed a 'cutting bench', and is rigid to withstand vibration during brick cutting. A six-foot (1.8 m) length accommodates up to three craftsmen, depending of course on what type of work they were undertaking.

11. They work up a Pier of Brick-work, about the same height to lay their *Rubbing-Stone* upon, which must be laid in Mortar that it may lye fast

The bench must not move, as the accuracy of any craftsman simultaneously engaged at the bench in scribing, cutting, or moulding a brick would be affected. A separate brick pier could thus be erected to the same working height as the 'banker' solely for the rubbing-stone. Moxon states the stone must be laid in 'Mortar that it may lye fast'. This secures the stone from slipping and rocking, and ensures it is bedded level across its rubbing surface. The stone would also be checked periodically to ensure it was not rubbing hollow, negatively effecting the preparation of the rubber. If so, it would be 'dressed' flat and re-bedded on mortar again.

12. A *Grinding-stone*, to sharpen their Axes, Hammers, Trowels &c. upon.

The grinding-stone was essential in the cutting-shed to maintain sharp axes, chisels, saws and other cutting tools used in 'hewing'. These when in constant use, would soon have dulled cutting-edges. A blacksmith only re-worked an edge once it began to lose its temper or hardness due to this constant re-sharpening.

There can be little doubt, however, though Moxon makes no mention of it, that the grinding-stone would have been used, where appropriate, to abrade shape on a rubber held against the spinning stone at the desired angle of contact. Such a practice has been seen to be employed by Flemish craftsmen in Arthur Vanderdorpe's workshop in Bruges, when preparing gauged brickwork for an ornate 'topstuck' to a seventeenth-century building in the town of Veurne (Figure 8). Moxon, for the next eight points, then lists and describes a variety of tools and equipment used for general brickwork. These are not germane to this work except for:

20. *Compasses*, to describe the several Mouldings on Wainscot or Pastboard.

The compasses were, and remain, important geometrical instruments for scribing the arcs and circles involved in setting out mouldings on wainscot, or pasteboard, suitably sized for cutting into templets to which the required brick shape could answer.

In concluding this examination of the seventeenth-century city bricklayer's tools, one must bear in mind how many or, more likely, how few cutting shops and craftsmen Moxon saw or spoke with during his research. This obviously limited the depth of this writing, as undoubtedly craft secrets would not have been openly shared. One must accept, therefore, that descriptions may be incomplete or, indeed, have omissions that would have been an essential part of contemporary practice with craft tools, equipment and materials.

In the third section of his treatise, Moxon considers and elaborates on good practice for foundations and sub-structure brickwork whilst again not germane to this thesis, Moxon (1703, 257) details ten '...neceffary Rules to be obferved in the laying of Bricks, to make the Walls ftrong and durable...'.

None of these ten rules, regrettably, make any mention of preparing or setting gauged work. Although good craftsmanship is mentioned, it is not detailed. One must remember that the seventeenth-century craftsman knew how to work 'according to demand'; a phrase often written into contemporary contracts.

A craft practice that would have definitely been employed, especially with regard to the execution of gauged work, was the use of timber profiles. Profiles were and remain the standard equipment for controlling accuracy of brickwork in the Netherlands where they are termed 'profiels'.

Taking into account how the skills of gauged work came to us from the Dutch, it then follows that these essential techniques necessary for achieving the same high standards came in a similar way. Profiles, as the name indicates, are the outlined shape of the proposed walling element. Set-out to the required line, level, and vertical position, they are then marked to the relevant gauge, allowing the bricks to be accurately set to lines strained from the appropriately braced profiles. Lines cannot be strained from newly laid gauged brickwork, like standard facework, as the bricks would slide or be pulled from position. Later eighteenth-century books do occasionally refer to timber guides to erect masonry to profile, such as 'diminishing rules' for erecting pilasters, or columns with entasis. All fail, however, to relate that these would have been fixed rather than brought to the wall in order to set-out, check, and guide construction.

Moxon (1703, 212) concludes with two more rules explaining the '...Act of Parliament...as it relates to *Bricklayers Work*'. This reference to Act of 1667, which

detailed the four classes of brick houses allowed after the Great Fire, emphasising how his treatise was primarily intended for city bricklayers and buildings.

Of singular interest with regard to the contemporary use of gauged brickwork is Moxon's Plate 5. This shows the principal elevation of a new city house of 'The second sort of Building fronting the Streets and Lanes of Note, and the River of Thames' (Figure 49).

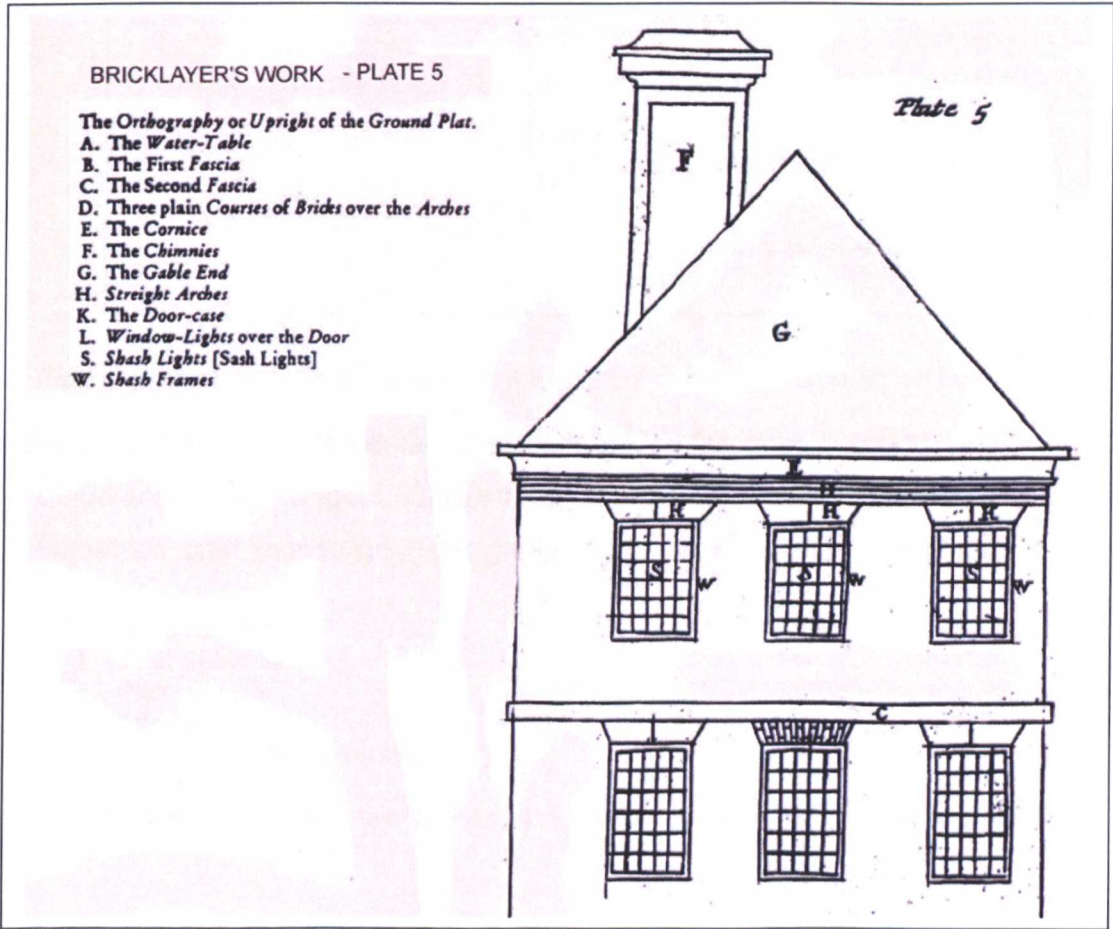


Figure 49 Moxon's plate 5 showing a drawing of a premier elevation on a brick-built city house.

One can see how all the principal architectural enrichments are intended to be in 'rubbed brick' shown and listed as:

- B, The First Fascia
- C, The Second Fascia
- D, The three plain courses of Bricks over the Arches
- E, The Cornice
- F, Streight Arches

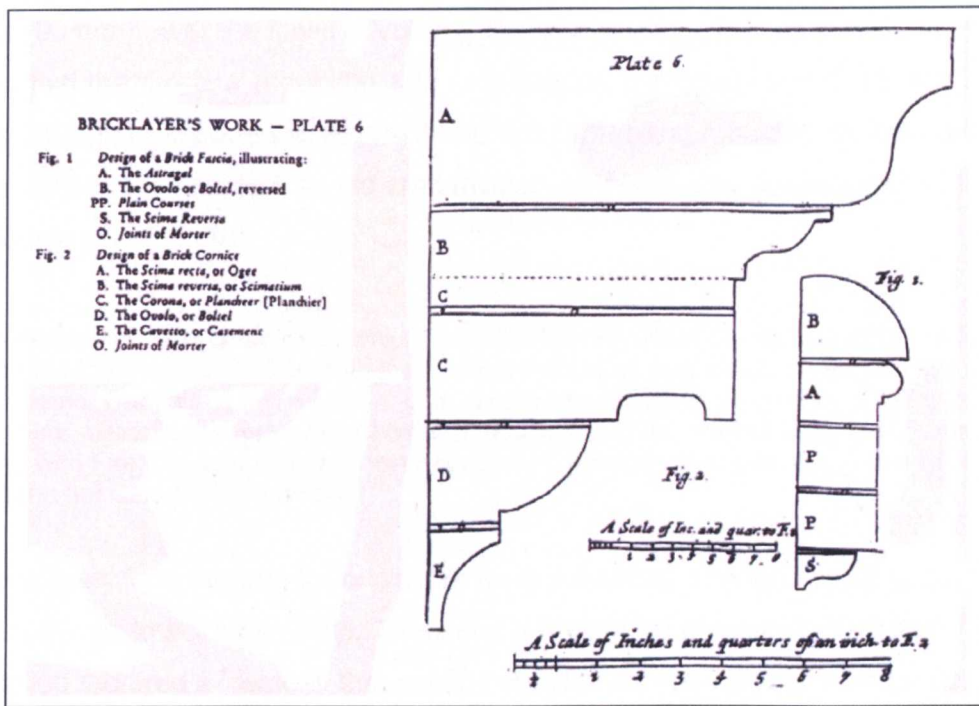


Figure 50 Moxon's plate 6 showing drawings of cut-mouldings for enriched fascia and cornice.

Elaborating further on the detailing of the moulded fascia and cornice, Moxon (1703, 267-68 and Plate 6) (Figure 50) illustrates and emphasises the importance of sound geometrical craft knowledge in designing and executing the cut mouldings:

- S. Is Scima reverfa.
- O. Joint of Morter.
- P. Plain Courfes.
- A. Afragal.
- B. Ovolo, or Boltel, reversed.

In the same *Plate*, you have the design of a Brick Cornice, and the Names of the Mouldings, are

- A. Scima recta, or Ogee.
- O. Joint of Morter.
- B. Scima reverfa, or Scimatium.
- C. Corona, or Plancheer.
- D. Ovolo, or Boltel.
- E. Cavetto, or Cafement.

In which Cornice, the Corona, or Plancheer, ought (according to the Rules of Architecture) to Sail over, or project more; but the length of a Brick being but about 8 Inches when its head is rubbed for hewing, it will not hang, if it fail over, more than is fhewn in the Draught, which is about 3 Inches and an half. But if you would make it to project more, then you muft Cement pieces to the ends of your bricks for tailing, or to make them longer: Of which Cement there is two forts, one is called cold Cement, and the other is hot, the making and ufe whereof, we will fhew towards the latter end.

Moxon here addresses the problem of insufficient brick stretcher length to rub and cut the designed moulding, yet also allow it to project or oversail beyond the stated $3\frac{1}{2}$

inches (90 mm), over the lower 'Ovolo' or 'Boltel' moulding. The concern here is to ensure that the 'Corona' moulding, laid as a header, is properly tailed-in to the wall and strong enough to support the weight of the two oversailing moulded courses directly above. Moxon then reveals an old craft mystery of 'cementing' bricks together to extend their length (1703, 286):

There are two forts of Cement, which fome Bricklayers ufe in Cementing of Bricks for fome kind of Mouldings, or in Cementing a block of Bricks, as they call it, for the Carving of Scroles or Capitals or fuch like, &c. One is called cold Cement, the other is called hot Cement, becaufe the former is made and ufed without Fire, but the latter is both made and ufed with Fire; the cold Cement being accounted a Secret, is known but to few Bricklayers, but the hot Cement is common.

Contemporary lime mortars for brickwork were not strong enough in setting to glue bricks together to act as a whole. To extend a header for a securely 'tailed-in' oversailing required a 'cement' that would not fail under load and/or through damp penetration. Likewise, for brick carving such as scrolls or capitals, it was vital that the bricklayer used a similar 'cement' to construct a solidly bedded 'block' of bonded bricks (also termed 'brick lumps') ready for the 'Trade Carver' to execute the carving. This could then be done without dislodging bricks or a small corner falling-out where work cut across joints. These 'cements', given in Moxon and re-created for use by the author, prove so tenacious that the brick will fail before the joint parts.

Although carving could be executed *in situ*, generally the 'lump' would be constructed in the cutting shed and then set into position as a solid masonry element. Preparation and construction of the 'lump' in the cutting shed gave improved control over quality of execution, especially with 'hot cement', which could be difficult to use on site.

Moxon (1703, 286) concludes his treatise by giving the ingredients for both 'hot' and 'cold' cement, and their respective methods of preparation:

To make the cold Cement.

Take ½ a Pound of Old Cheffire-Cheefe, pair of the Rine, and throw it away, cut or grate the Cheefe very fmall, and put it into a Pot, put to it about a Pint of Cows-milk, let it ftand all Night, the next Morning get the Whites of 12 or 14 Eggs, then take ½ a Pound of the best Unslackt or Quick Lime that you can get, and beat it to Powder in a Morter, then fift it through a fine Hair Sieve into a Tray or Bole of Wood, or into an Earthen Dift, to which put the Cheese and Milk, and ftir them well together with a Trowel, or fuch like thing, breaking the Knots of Cheefe, if there be any, then add the Whites of the Eggs, and Temper all well together, and fo ufe it; this Cement will be a White Colour, but if you would have it of the Colour of the Brick, put into it either fome very fine Brick-Duft, or Almegram, not too much, but only juft to colour it.

To make the hot Cement

Take one Pound of Rozin, one Quarter of a Pound of Bees-Wax, half an Ounce of fine Brick-Duft, half an Ounce of Chalk-Duft, or Powder of Chalk, sift both the Brick-Duft and Chalk-Duft through a fine Hair Sieve (you may beat the Brick and the Chalk in a Mortar, before you sift it) boil altogether in a Pipkin, or other Veffel, about a quarter of an hour, stirring it all the while with an Iron or a piece of Lath or fuch like, then take it of, and let it stand 4 or 5 Minutes, and 'tis fit for use.

Note, That the Bricks that are to be Cemented with this kind of Cement, must be made hot by the Fire before you spread the Cement on them, and then rub them to and fro on one another, as Joiners do, when the Glue two Boards together.

The remainder of Moxon's treatise is wholly concerned with the setting out of arches, being of interest as they are of gauged construction. He concentrates primarily on the, 'Semi-Oval, being an Ellipfis Arch' [semi-elliptical] and the "Streight Arches" [flat], (Figure 51).

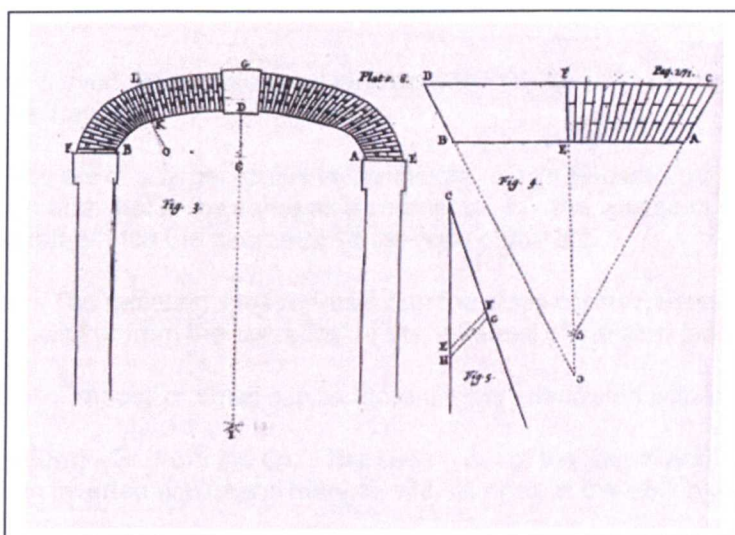


Figure 51 Moxon's plate 8 showing drawings the setting out of a flat and semi-elliptical arch.

In this respect Moxon (1703, 279) emphasises:

Other kind of *Circular Arches*, as half Rounds and Scheams [segmental], being described from one Centre, are so plain and easy, that I need say nothing concerning them.

The first reason for choosing semi-elliptical and straight arches to explain the setting out procedure was the popularity for the semi-ellipse for wide-span entrances into courtyards; here horse-drawn vehicles could pass with the driver still in position as this arch gave maximum height, and thus headroom, within its span. The straight arch was desired for classical brick facades as a means to securely bridge an opening yet provide the desired flat beam-like effect.

The second reason for the selection of semi-elliptical and straight arches is the intricacy of their setting out, establishing individual voussoir positions and their precise shapes

for the cutting templets; vital for accurate gauged work. In the straight arch individual voussoirs up to the central 'key brick' are unique to their position; replicated (but only as a mirror-image) on the other half of the arch. With the semi-elliptical arch, the same factors apply. However, the arch is geometrically set-out from three separate centres or 'striking points' and so individual voussoirs relate only to their relative radial point. It is therefore a complicated arch to draw, set-out, cut and 'turn' (build) to ensure an accurate, neat, and precise arch.

In reading Moxon's description of drawing, setting out, and establishing the face templets, for gauged arch voussoirs, one needs to be aware of his seventeenth-century terms and their meanings in modern terminology to relate more clearly to his instructions:

Hanse - The curved rise situated mid-way between the 'crown' and the springing-line'; today known as the 'haunch'.

Scheam - The arc of a larger radius in the middle of a three-centred or elliptical arch. It can also mean an arch that is the same as a segmental, but the voussoirs radiate to the centre of the opening rather than the geometric radial-point of the arc.

Sommering - The radiating lines representing the sides of the voussoirs as drawn to either the 'striking-point' or from the 'extrados' to the 'intrados' of the arch face.

Chaptrels - An 'impost' or small capital more usually associated with vaulting.

Oxi (Oxigonium) - Or 'from the Oxi'. The setting out of the 'skewback' in a straight (flat) arch by drawing an inverted equilateral triangle, with its apex at the 'striking-point', to create an angle of 60°.

Prick - The setting out mark made by the point of the compass or divider, when 'pricking-out' or marking the positions of the voussoirs along the extrados, and sometimes the intrados, prior to drawing them out.

The difficulty today in correctly following and understanding Moxon's instructions so that either arch could be prepared and set as gauged work, becomes very apparent upon reading his instructions on establishing the size of joints between voussoir templets:

...then make another fommering mould to fit between two of thefe Lines, abating fo much as you intend the thicknefs of your Joints of Morter to be, which if you fet very clofe Morters, the breadth of the Line [black-lead pencil] will be enough to allow...(Moxon, 1703, 275)

It is important to study and tease-out the hidden meanings within Moxon's detailed explanations, made difficult by the use of old craft terms. It is however vital as one gains a deeper understanding of contemporary practices of late seventeenth and early eighteenth-century bricklayers, and the consequent subtle aesthetic effects of their skills on their gauged arches.

2.3.6 The Semi-Elliptical Arch

The radiating, or sommering, of the voussoirs to the arc of the arch from Plate 8 of Moxon's treatise is taken from the centre, or 'striking-point', marked I (see figure 51). Moxon gives two methods for setting out the haunch. In the first, the extrados (F-L) and intrados (B-K) are divided into so many equal parts (in this case 18 courses) and the lines then scribed between them. Moxon points out, however, that this method of establishing the voussoirs, although the strongest (or indeed dividing the upper hanse to the geometrical striking point at centre marked O), makes them noticeably smaller.

On the right-hand side of the same arch, Moxon shows an alternative method, with accompanying explanatory text, whereby the courses of the scheim and hanse divide into equal voussoir sizes, deemed visually more harmonious.

It is interesting to note that, until the Restoration, it was generally the tendency for arches of whatever size to be constructed in half-lapped stretcher bond. In Moxon's arch, it is drawn in English bond. This reflects a change in fashion towards showing some arch faces in quarter-bond, which appears to be uniquely English; though its use also spread to the British Colonies. Indeed, the flat arch of Helder's masterpiece of 1675 (at the Victoria and Albert Museum) is constructed with an English Bond face. The same bonding is also used for the gauged flat arch above the entrance doorway to the south wing of Morden College Blackheath (Kent) (1695). Generally, however, it is Flemish bond that was preferred when quarter-bonding a flat arch face.

Moxon has two errors on either side of his drawing of the English bonded arch. On the left-hand side the error is simply one of scale, as the central header between the two closers appears like a stretcher compared with the other headers in the same course. On the right-hand side, however, the bond is incorrect, as one of the 'closers' is placed on the stretcher course instead of being placed between the headers, as correctly depicted on the left-hand side.

This was often a part-aesthetic quarter-bond created by 'scribing' false, or 'dummy' joints on to the constructional half-bonded brick veneer to create the illusion of thick-walled English or Flemish bond. An interesting use of dummy joints has been noted on a half-bonded gauged semi elliptical arch to the main gateway at Chatham Dockyard (Kent) (1718), to create the illusion of English bond (Figures 52 and 53).



52 Semi-elliptical gauged arch to the main gateway, Chatham Dockyard (Kent), 1718, (N.A. Howard).



Figure 53 Close-up of the use of 'dummy-joints' to create aesthetic quarter bond to the half-bonded gauged arch of the main gateway, Chatham Dockyard (Kent), 1718, (N.A. Howard).

To create a 'closer', either side of the central header on alternate header courses, dummy joints were scribed into a stretcher, a quarter brick in from either end and parallel to the soffit of the arch at that point. This was repeated on the two-brick-deep soffit. These dummy joints, measured at $\frac{1}{4}$ in (5 mm) depth would have been carefully pointed before the final rubbing-up phase to complete the overall illusion.

2.3.7 The Straight Arch

It is the 'straight' or flat arch that comes to mind when one considers the brick architecture of the Renaissance. It was employed to horizontally span an opening to be stuccoed so creating the appearance of the stone lintel or beam it was substituting. This style of arch became popular in England at the time of the Anglo-Dutch style of architecture and craft practices. Moxon emphasises the importance of this form of arch construction and the related craft knowledge (Moxon, 1703, 279):

But since *streight Arches* are much used and many Workmen know not the true way of describing them, I shall write something briefly concerning them.

He discusses establishing the skewback, stressing how the angle may be made less acute if the width of the piers between openings was two bricks or less (1703, 279-80):

...*Streight Arches* are used generally over Windows and Doors, according to the breadth of the Piers between the Windows, so ought the Skew-back or Sommering of the Arch to be; for if the Piers be a good breadth, as three or four Bricks in length, then the *Streight Arch* may be described (as its vulgarly said) from the Oxi, which being but part of a Word, is taken from the word *Oxigonium* signifying an Equilateral Triangle, with three sharp Angles; but if the Piers are small, as sometimes they are but the length of two Bricks, and sometimes but one Brick and an half, then the breadth of the Window or more, may be set down upon the middle Line for the Centre, which will give a less Skew-back, or Sommering, than the centre from an *Oxi*.

The two common methods to determine or 'describe' a skewback are detailed. First, by geometry, creating an equilateral triangle below the opening from either 'springing point' to establish the 'striking point', from this the skewback could be drawn giving a constant angle of 60°. This has always been considered to be best angle for this arch as it gives a perfect counter-thrust to the reciprocal triangular area of direct load above the opening.

The second method creates a less acute skewback achieved either by geometry or a mathematical formula known as the 'One-Third Rule' (section 2.4.6). This gives Moxon's skewback on the left-hand side a drawn angle of 65°, whereby 70° is usual. In Moxon's example on the right-hand side, he establishes the striking point a vertical distance down the centre line from the springing line that equals the span of the relevant arch.

Moxon gives as the need for this reduction the narrow piers between openings – especially on narrow-fronted terraced houses – unable to accommodate the 60° angle of skewbacks as with a one and a half-brick wide pier, for example, the opposing springing voussoirs would collide.

The straight arch is generally, though not always, found to be set-out to a vertical face height of four standard courses of brickwork which, in the seventeenth century gives:

12 Inches; but moft commonly thefe fort of Arches are but 11 Inches in the height, or thereabouts, which anfwers to four Courfes of Bricks, but you may make them more or lefs in height according as occafion requires... Moxon (1703, 274)

Having drawn the outline of a straight arch, Moxon details the techniques of dividing the arch face into the number of courses the arch would contain. The first involves setting out the voussoirs on the extrados with the aid of:

...Compaffes the thicknefs that a Brick will contain, which I fuppofe to be two Inches when it is rub'd (Moxon, 1703, 281).

Curiously, though he correctly provides for the arch being worked to a 'key brick', which is best practice, he shows a joint at the centre in his drawing.

To establish the shape of individual voussoirs, for setting out templets, two methods are given. In the first, the positions are 'pricked-out' on the extrados and drawn from each by pencil run along a rule resting against a nail placed at the striking point of the arch. In the second method, voussoir positions are evenly spaced on the extrados, but also - to lesser widths - along the lower line or intrados. These radial lines are then drawn along a ruler placed to link these two opposing marks.

Moxon finally considers the bonding pattern of the straight arch face as a half-bond of alternating stretchers and headers (see Figure 51); this is in the manner of the Dutch. He correctly advises caution when bonding courses in an arch if odd or even in number. If odd, preferable for symmetry and bonding of the 'key-brick', then the first, or springing, voussoirs can be identical, either headers or stretchers at the bottom. If even, then the 'springers' on either side must be different, a header opposing a stretcher.

Summary

The post-Restoration period heralded a golden age for English brickwork, once again influenced by the craft practices of the Dutch. The degree of accuracy required to set-out, cut and rub, and lay a superior grade of low-fired rubbing brick, with joints as fine as 1 mm, saw the emergence of the term gauged work. The reduction of the joint size was part of the classical masonry tradition of minimising the detracting impact of many bricks within a classical enrichment. Gauged work was an essential part of the principal

fronts of new brick buildings after the Great Fire of 1666. That it was an integral part of a first-class bricklayer's range of skills is emphasised by study of Moxon's seminal craft treatise, *Mechanick Exercises: OR, the Doctrine of Handy-Works. Applied to the ART of Bricklayers Work*, of 1703.

2.4 THE GEORGIAN PERIOD (1714-1830)

The Georgian period covers the reigns of George I (1714-27), George II (1727-60), George III (1760-1820) and George IV (1820-30), although the period from c.1800 to 1830 is also sometimes termed the Regency.

This was a time of great social, technological, and scientific change. It was also one in which the population began to grow and transform the nation from a rural to an urban society and, despite the problem of poverty, greater wealth was being generated and shared to a wider section of the populace. The expanding British Empire created colonies providing raw materials for the factories, benefiting from the many scientific and technological innovations aiding quality and quantity of production, but also markets for their manufactured goods.

This greater prosperity had many consequences Lawrence and Chris (1996, 17-18) suggest:

[It]enabled more people from the top end of society to make the Grand Tour and be exposed to other cultures, particularly the classical. They were extremely impressed by what they saw and their views filtered down – many became infected with an enthusiasm for everything classical, which, in turn, became synonymous with the notion of 'good taste'....

Georgian houses appeared in a complete range of sizes – the small one was the latest to appear in the final quarter of the Eighteenth century. By then it was one style in a variety of different sizes, thus catering for upper, middle and lower classes...

The nation's strong affection for brickwork and a popular classicist style of building allowed the love affair with Dutch-styled gauged brickwork to be fully 'Anglicised', at all levels of design and use. When the English take something to their heart and embrace it, they do so with an almost all-consuming passion. It is either right or wrong and no half-measures are tolerated. They also want to fully examine and explore all its possibilities; often to the point of eccentricity.

Georgian builders often combined coloured bricks for a reticent polychromatic effect, especially around door and window jambs, pilasters, and some quoins, the best of this brickwork being executed in rubbers of contrasting colours to the facework. An example of such finely gauged pilasters is at Bradbourne, Larkfield (Kent) (1714). Describing the gauged work of The Convent at Longbridge, Farnham (Surrey), Lloyd (1925, 220) says:

The walling is built with 2-2¼ ins bricks, rubbed and edged, with ¼ in joints. The dressings are built with 2½ ins bricks and invisible joints. This house is a fine example of cut, rubbed, and gauged brickwork...

Also in wealthy Farnham, where there was the money to finance such costly brickwork, Lloyd, (1925, 222) describes the fine red brick outside of Wilmer House as:

Perhaps the most remarkable elevation in cut and moulded brickwork extant. The whole front is gauged. The bolection mouldings of window architraves are exceptional. The cornice is also excellent.

Chicheley Hall at Chicheley (Buckinghamshire) (1719-24), designed by Francis Smith of Warwick, has the main south and east facades of finely coursed ashlar gauged work and enrichments; and niches on some of the associated buildings. All local bricks, including the orange/red-textured rubbers that match the standard face bricks, were used for this most gracious of buildings (Fig 54). By this date the fashionable use of gauged work for whole fronts was fast declining, perhaps due to cost as much as, in the opinion of some, architectural indigestion (Cruickshank and Wyld, 1975, 185).

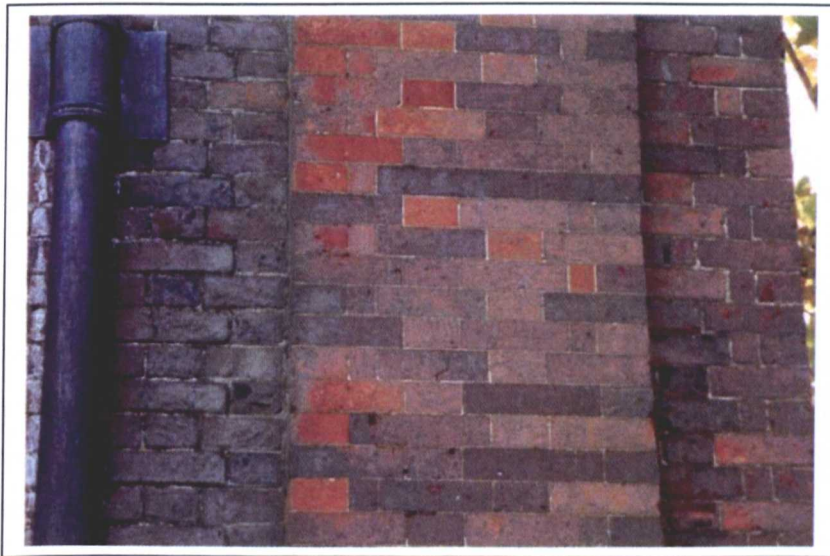


Figure 54 Close-up of the ashlar gauged work and standard facework at Chicheley Hall (Buckinghamshire), 1718, which reveals they are of the same bricks.

Georgian brickwork could also be accentuated with terracotta enrichments modelled to resemble stone. Terracotta came to prominence again during this period. The most famous factory was that founded by Eleanor Coade in the 1760s, producing the high-quality 'Coade stone' from 1767 until 1835. This artificial stone product was particularly prized for embellishments to openings, for arches with vermiculated voussoirs, rusticated with brick, and for a wide range of sculptured keystone motifs. The use of

gauged work declined, becoming confined to arches, aprons and other dressings, as this period drew to its close:

2.4.1 Building Acts and Builders' Pattern Books

The Building Acts, which only applied in London, following the Great Fire were, to a degree, nationally influential as their interpretation and enactment affected the fashion for the popular use of brick and how it was subsequently structurally and decoratively applied. This was not only reflected in the choice and articulation of gauged work, but in establishing the first strictly Georgian house out of its late seventeenth-century roots.

Summerson (1947, 52) states:

Continued fear of conflagrations prompted a Statute of 1707, which abolished the prominent wooden eaves-cornices which were such a striking feature of the streets and squares of the Restoration....

By the London Building Act of 1709, timber window frames, instead of being almost on the same plane as the brick face, were to be set back 4 ins (102 mm). The more stringent and effective London Building Act of 1774 virtually prohibited the use of exposed timber work on buildings, stating that entire fronts were to be of brick, stone, burnt clay, artificial stone, or stucco.

These and other Acts, and the influence of numerous pattern books, gradually led to the standardisation of architectural design and, in turn, the components themselves; even the bricks. This influence of pattern books on Georgian architecture was considerable, providing builders with sufficient knowledge to erect a building to the satisfaction of the client. Publications also gave technical guidance to skilled craftsmen; examples include *The City and Country Builder's and Workman's Treasury of Designs* by Batty Langley (1740), and *The Complete Body of Architecture* by Isaac Ware (1756). These enabled building owners to become more conversant with details of proposed works, a consequence of which was the erection of many fine buildings spoilt only by the repetition of detail.

R. Campbell in *The London Tradesman* of 1747 warns of the perils of master bricklayers designing and building. 'A master bricklayer thinks himself capable to raise a brick house without the tuition of an architect... It is no new thing in London for these master builders to build themselves out of their own houses, and fix themselves in gaol with their own materials' (Lynch, 1994, 51)

Despite this cautionary note, Amery (1974, 12-13) emphasises the importance of pattern books to eighteenth century domestic architecture which:

... between 1715 and 1730, was stable and uniform. The Palladian gospel had been spread by the pattern books. These books were compiled by carpenters like William Half-penny of Twickenham or the carpenter/architect, Batty Langley, and they were full of good drawings of details and the orders and contained accurate plates of doors, windows and other elements. Sold to both the gentry and craftsmen, they spread the word of self – improvement...

The proliferation of pattern books reached its height in the years between 1725 and 1760, after which it diminished (Summerson, 1947, 58):

...with the expansion of the architectural profession and the coincident repression of the craftsman's initiative. In the latter part of the century we get a very different wave of book-publishing, sponsored not by craftsmen but by architects, and designed not to instruct the workman, but to charm the potential client.

Yet, and with particular regard to the majority of brick-built Georgian London, Cruickshank and Wyld (1975, 1) emphasise the elegance:

...was formed not by great architects but by master builders, entrepreneurs and all kinds of speculators. Yet the coherence it had, both in construction and design, belies this curiously multiple parentage and reveals that a great binding force was at work: the orderly flexibility of 18th century architectural classicism.

2.4.2 Brickmaking

Brick manufacture in London was still controlled by the Tylers and Bricklayer's Company; though their powers were receding, necessitated by the demands to quickly re-build after the Great Fire of 1666.

Though some rubbing bricks from this period would appear to have 'Spanish' (ground sea-coal ash finely sieved with clay mixed to give an integral fuel) within their body, which was a unique feature of the 'London Stock' brickmaking process, it was preferable to use unadulterated clean brickearth or clay. Creating an internal fireball within a rubber meant it was likely to burn harder internally, or leave particles of clinker within its body, impeding cutting and rubbing to shape.

At the beginning of this period, and later in the eighteenth century, red brick was fashionable for gauged work. Nicholson (1823, 344) observes:

...the Red Bricks ...are made of a particular earth, well wrought, and little injured by mixtures; and they are used in fine work, in ornaments over windows... These are frequently cut or ground down to a perfect evenness, and sometimes set in putty instead of mortar; and thus set they make a very beautiful appearance.

One particular rubbing brick is deemed worthy of naming by Nicholson for its excellence (1823, 344-45):

... is the Hedgerly Brick: it is made at a village of that name, of the famous earth called Hedgerly loam... of a yellow-reddish colour, and very harsh to the touch, containing a great quantity of sand....

Nicholson urges caution, however, regarding selecting bricks for rubbers, in words that still apply today:

The Red Cutting Brick, or fine red, is the finest of all bricks. In some places that are not at all acquainted with this; in others, they confound it with the red stock, and use that for it....

The Red and Gray Stock are frequently put in gauged arches, and one as well as the other set in putty instead of mortar: this is an expensive work but it answers in beauty for the regularity of the disposition and fineness of the joints, and has a very pleasing effect.

The fine Red Brick is used in arches ruled and set in putty in the same manner; and, as it is much more beautiful, is somewhat more costly. This kind is also the most beautiful of all in cornices, ruled in the same manner, and set in putty.

By 'Gray' [grey] stock, Nicholson is referring to the 'London Stock' brick, generally clamp-fired, varying in colour from brown through plumb red to purple, and where mixed with lime it would burn to the more familiar buff to yellow tones. The latter suited the fashion of the period, as orange and red coloured bricks became less regarded; '...the colour is itself fiery and disagreeable to the eye' (Ware, 1756, 61). The aspiring middle classes wanted their homes to resemble the stone-coloured Palladian manor houses of the wealthy.

Lloyd emphasises the type of 'London Stock' employed for the gauged enrichments:

The tendency to build with grey, cream and yellow stocks which became general in London and its vicinity was not unconnected with the development of Kentish and other brickfields where the available earths produced these colours, and here mention should be made of those bright yellow bricks, called Malms, a good example of the use of which is the elevation of Bath House, Piccadilly, and which are still used for gauged arches, etc (Lloyd, 1925, 58),

'London Stocks' were in 12 grades, according to Dobson's writing of 1850 (Searle, 1936, 80), the premier grade being:

'Malms'. These are the best building bricks, and are only used in the best descriptions of brickwork; their colour is yellow.

Alan Cox (Hobhouse and Saunders, 1989, 4) explains precisely the term Malm:

In its pure state it was referred to as 'malm' and 'malms' or malm bricks and considered the best type of London stock brick. The brickearth is high in silica (about 65-75%), low in alumina (8-11%), and with a higher than usual lime content of between 7-9%. Normally the iron oxide in a clay will tend to produce red brick but lime will nullify this and produce a characteristic yellow-or white-coloured brick (this is true of any yellowish or whitish brick whether it be a London stock, a Suffolk white, or a yellow gault)...

In the London Stock range of bricks it was the malms cutters that were used as rubbing bricks. (Figure 55).



Figure 55 Gauged work using Malm cutters at 30 Portland Place, London, c.1779, (Alan Cox).

Of note, studying Cox's description is the naturally high level of silica in the Malm (65-75%), a feature of bricks used for gauged enrichments. 'Malm cutters', like contemporary rubbers, were produced to the same size as the standard bricks.

The prices for best malms during the Georgian period were (Cox, 2002):

Year	Price per 1,000
1787	80 shillings
1794	80 shillings
1810	105 shillings
1813	130 shillings

In other areas, the desire to copy this fashion for 'grey' bricks could be met with such bricks as gaults (variously spelt galt, galte, and golt) from the burgeoning brickfields of Bedfordshire, Cambridgeshire, and Norfolk; as well as Kent and Hampshire. Gaults are made from a stratum of calcareous clay that lies between the Upper and Lower Greensand formation.

There is, however, 'widespread and indiscriminate use of the term 'Gault' as a descriptor for pale-coloured bricks, irrespective of their origin or physical characteristics'. (Firman, 1998, 10-11). Other calcareous white and yellow burning mudstones, brickearths and clays exploited across these regions produced bricks that were not gaults. The 'Suffolk Whites' are one such brick - 'the brickyards were 30 to 40 miles east of the nearest outcrops of Gault and Greensand'.

The best 'Suffolk Whites' were prepared and used as rubbers (though harder) for gauged work. These were termed Suffolk 'cutters' or 'clippers' many of these were 'imported' into the city for rubbed and gauged arches, such was their regard.

Of major significance to the use of brick in this period were the changes in transportation with the advent of the canals from the 1750s. Barges, capable of carrying up to 25 tons over 3,000 miles of national canal network, meant that bricks were delivered much further afield, beyond their traditional area of manufacture and use.

Brick prices varied enormously over this period and with rubbing or cutting bricks continuing to demand a premium. Summerson (1947, 64) lists brick prices delivered per 1,000 in 1748:

Place bricks	..	..	..	..	..	14s.
Grey stocks	..	..	..	..	..	18s.
Do. (specially picked for uniformity of colour)	..	..	..	..	20s. or 22s.	
Red stocks	..	..	..	..	..	30s.
Cutting bricks [for gauged work]	..	..	..	..	60s.	

By 1813 these prices, according to Cox (2002) were:

Place bricks	55s
Grey stocks	65s
Cutting/rubbing bricks	85s.

Nicholson (1823, 345) reveals this was still true towards the end of the period:

The fine red cutting English Bricks are twice, or more than twice, the price of the best Gray Stocks; the Red Stocks half as dear again as the gray; and the Place Bricks, as they are much worse, so they are much cheaper, than any of the others.

2.4.3 The Georgian Bricklayer

In the hierarchy of the Georgian building trade, the premier craftsmen were the masons, bricklayers, and carpenters in that order, with the master mason or bricklayer responsible for a structure in either stone or brick.

The time-served apprenticeship continued to be the route into the craft, with periods of learning varying from between four to seven years before qualifying as a journeyman, the best going on to become respected master craftsmen. The guild system, such as the Tylers and Bricklayers Company, was still operational at the beginning of the period, but rapidly losing its power and control, due to the faster pace, quantity of construction, and an ever more mobile workforce.

Summerson (1947, 53) describes a Georgian London master craftsman as being:

...as a rule, a man of considerable skill and status – proud, conscientious and expensive. He lived well, and drank heartily. He was capable of writing a fairly good letter and could usually (if he were a mason, bricklayer or carpenter), make a plain “draught” of a small building.

A new capitalist breed of bricklayer emerged aspiring to being a 'master builder' contracting for complete structures, and not just the brickwork, in the fast developing speculative property market of the hugely influential city of London.

Some of the influential city master bricklayers of the Georgian period were:

- William Tufnell
- John Prince
- William Emmett
- George Hoare
- Solomon Bray
- Joseph Pratt jnr.
- Robert Todd
- William Stacey
- William Whitehead
- John Whitehead
- Francis Read
- Martin Stutely

These men, Russell and Chris (1996, 29) record:

Often worked on each others' contracts and consequently a system of barter was widespread. Houses were frequently built with very little money actually changing hands.

Obviously there were times when brickwork had to be charged for and in such instances contracts would be drawn up in a perfectly legal manner. Payment 'by the piece' was a popular eighteenth-century craft practice and price books recognised rates on a linear 16½ feet (a rod) of bricks laid. How gauged work was measured and priced in this period can be assessed by studying Neve (1726, 12):

[Of meafuring Arches]. In meafuring of them, whether they are Straight, or Circular; they muft be meafured in the middle, i.e. If a ftraight Arch be twelve Inches in height, or depth, the length muft be meafured in the middle of the twelve Inches, which length will be no longer than if it were meafured at the underfide, next to the head of the Window, by fo much as one fide of the fpringing of the Arch is skew'd back from the upright of the Jambs, Peers, or Coins of the Windows.

14. *Price]* For the Workmansfhip of *ftraight Arches*, well rubb'd, and handfomely fet (of Brick) in *London*, about 8d. or 9d. *per* Foot; but in fome parts of Suffex and Kent, they will not do it under 12d. *per* Foot, running Meafure. But in *London*, if the Workmen find Materials, then 'tis about 10d. or 12d. *per* Foot.

Skeen, or *Scheam Arches*, and *Elliptical* ones; of *rubb'd Brick*, are common about the fame Price with ftrait ones. But *Sheam Arches* of unrubb'd Bricks are commonly included with the plain Work, unlefs the plain Work be done at a reafonable Price: But you muft here note, that the Mafter of the Building (or Owner) is at the charge of the Centers to turn the Arches on; and not the Workman, unlefs he be allow'd for it in the Price of the work.

Pain emphasises that gauged work is measured and priced upon a different and more expensive system:

Rubbed Arches of any Sort are done from 1s. 6d. to 20d. per Foot; workmanfhip from 10d. to 1s. – Plain Facios rubbed 1s. 1d. per Foot; Workmanfhip 8d. – Brick Cornices from 4s. to 5s. per Foot; workmanfhip from 3s. to 3s. 6d. – Cutting Bricks for rubbed and gauged Work, from 40s. to 2l. 10s. per Thoufand (Pain, 1769, 1)

He concludes by providing a valuable exercise in how a new house might be priced for a bricklayer's work. From this, one can determine how gauged work was considered an essential part of a brick-built property; and was around five percent of the overall brickwork price, (Pain, 1769, 8).

An Eftimate for Building a New Houfe.			
	£.	s.	d.
To 600 Loads of Digging in Cellars and Foundations, at 6d.	15	0	0
Per load - - - - -			
68½ Rods of Brick-work, reduced to 1½ Brick, at 6s. 5d. per Rod	428	2	6
21½ Square plain Tiling, at 1l.8s. the Square - - -	30	2	0
150 Feet Run of Arch Drain, at 2s. 6d. - - - -	18	15	0
45 Yards Brick Paving in Morter, at 2s. 6d. - -	5	12	6
92 Feet of rubbed and gauged Arches to Windows, at 1s. 6d. - -	6	18	0
112 Feet of rubbed and Gauge in Facio, at 1s. - - - -	5	12	0
270 Feet of rubbed Returns, at 6d. - - - - -	6	15	0
120 Feet Run of rough Splays, at 1½d. - - - - -	0	15	0
45 Feet fuperficial of fummered Arches 1½ Brick, at 4d. - -	0	15	0
165 Feet Run of Groin, at 6d. - - - - -	4	5	0
236 Feet 6 Inches of Foot Tile Paving, at 4d.	3	19	0
143 Feet Run of common Drain, 10 Inches wide, 9 Inches high, 4 Inch Walls, covered with Foot Tile, paved with flat Bricks, at 1s.	7	3	0
Total of Bricklayers Work - £.	533	14	0

Dearn (1809, 34), remarking on pricing gauged work, states:

The gauged arches, are most commonly deducted; but whether deducted or not, are always charged separately as the price of gauged work is seldom less, than five times as much, as is allowed for the best facing.

Under the general heading of Rubbed and Gauged Work, he states (1809, 58):

This work is measured either by the foot superficial, or by the foot run, and set either in putty or mortar.

Gauged arches to doors, windows, &c, are set in putty and charged by the foot superficial according to their different constructions...

Also that an extra price is allowed for gauged work set on a circular, elliptical or any swelling bow plan

Dearn (1809, 99-101) then goes on to detail contemporary practice in measuring various gauged arches to determine their individual prices. He also discusses brick cornices, adding that they were formerly very much in use but had entirely fallen out of fashion and that work set in front mortar was half the price than that set in putty.

2.4.4 Tools and Equipment for Gauged Work

As Moxon's treatise is an invaluable source of information on the tools, materials, and craft practices of the seventeenth-century bricklayer, so the building and pattern books of the eighteenth and early nineteenth century are for the Georgian period.

At the beginning of the period, Moxon's descriptions of the art of the bricklayer remained true for the Georgian cutting shed and site. This is largely why Neve, in his original publication (under the pseudonym T N Philomath), of *'The City and Country Purchaser and Builder's Dictionary'* of 1703, (second edition, Neve, 1726), uses many of Moxon's own words within his text. One needs to go to the end of this period and read another's observations, therefore, to fully assess how things had continued to develop in the cutting shed and gauged work.

Nicholson (1823, 384-89), in describing the tools and their use, emphasises how gauged work was now being reserved mainly for arches; hence his emphasis on preparing voussoirs rather than mouldings. Several of the tools Nicholson lists (except the brick axe, as it underwent a significant change) are omitted here as they have already been given and their use described in section 2.3.5.

BEDDING STONE – A straight piece of marble used to try the rubbed side of a brick.

This is an early reference to a 'bedding slate', a flat slab of marble for testing the bedding of a cut and rubbed brick to ensure it is flat on its bed face and follows the shape of its templet. Later in his list (Nicholson 1823, 389) returns to elaborate on the bedding stone:

The *Bedding-Stone* consists of a marble slab, from eighteen to twenty inches in length, and from eight to ten wide, and of any thickness. It is used to try whether the surface of a brick, which has been already rubbed, be straight, so that it may fit upon the leading skew back, or leading end of the arch.

The *Hammer* used by bricklayers (*fig 7*) is adapted either for driving, or dividing bricks...the axe part, more nearly resembles an adze, but is not so broad in proportion to its length.

This is what we now term a 'brick hammer', though the drawing in Nicholson's plate is incorrect. The axe blade should, be turned through 90° so that it 'resembles an adze' as he describes, – in his drawing it does not (Figure 56).

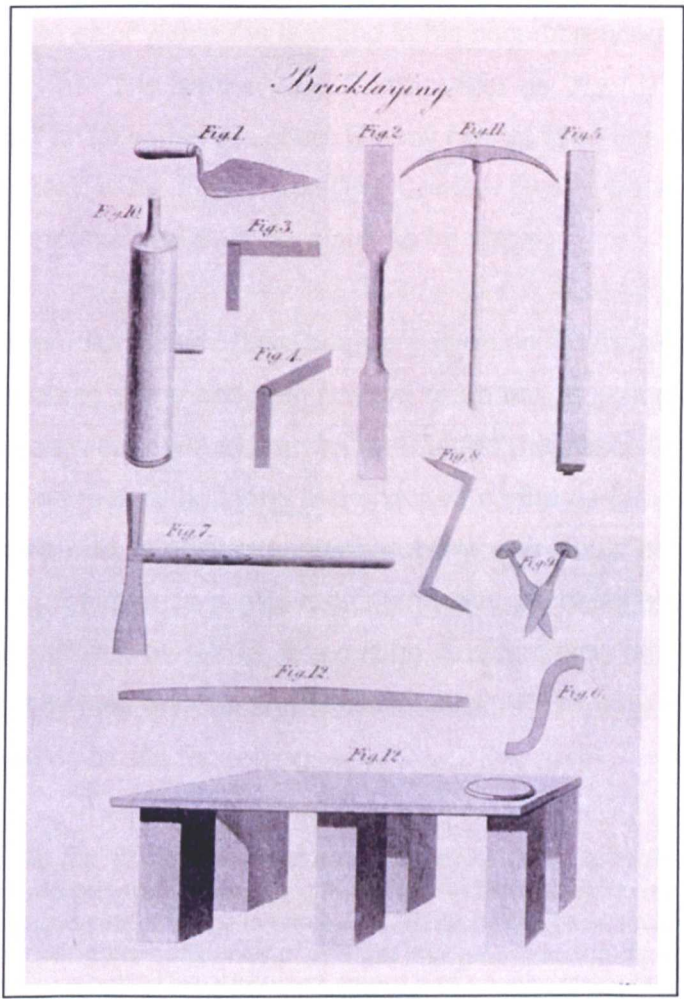


Figure 56 Plate depicting tools and equipment used by an early nineteenth-century bricklayer, from Peter Nicholson's 'New and Improved Practical Builder and Workman's Companion' of 1823.

The development and popularity of this particular cutting-tool was undoubtedly instrumental in the decline of the use of the Moxon-styled short brick axe.

The *Chopping-block* is made of any chance piece of wood that can be obtained, of about six or eight inches square, when for two men to work thereon; and lengthened in proportion for four or more. It is generally supported, about two feet three inches from the ground, upon two or more fourteen-inch brick piers. It is better to have several blocks when they can be obtained, in preference to allowing many hands to be employed at one; because the vibrations communicated by one workman are liable to inconvenience another.

The Chopping-block is used for reducing bricks to any required form by means of the axe.

The term 'Chopping-block' denotes its use – to facilitate the cutting, or chopping, of a brick to shape. It was not placed on the bench or 'banker' as Nicholson terms it, but was frequently positioned so as to isolate the resultant vibrations created from precise work being undertaken at the bench.

Nicholson shows an error within the text and in his accompanying Plate of tools and equipment, for he has 'The Banker' and 'Camber Slip' as '(fig. 13)' in his text, yet denotes both, as 'Fig 12' within the plate. Clearly he intended one, 'The Banker', as it comes first in the text, to be 'Fig 12' and 'The Camber Slip' to be 'Fig 13'. Also the Rubbing-Stone is not marked B, in his plate, as he states.

All drawings and templets would have been prepared on the 'banker', the rubber squared on the rubbing stone and then scribed or 'tinned' for axing at the chopping-block. The prepared rubber would then be returned to the bench for the axed surfaces to be rubbed flat on the rubbing stone and checked on the bedding slate against its templet and scribed with its positional number. Here also would be performed any final fine shaping, using the reverse profile running moulds, as described earlier. This would be in conjunction with any bevelling, fine cutting, and trimming with the tin saw. This would be followed by final dry bonding of the feature (or part of it) to test accuracy before sending out on to site for setting.

...the *Camber-slip* (fig 12,) is a piece of board of any length or breadth, made convex on one or both edges, and generally something less than an inch in thickness: it is made use of as a rule. When only one side or edge is cambered, it rises about one inch in six feet, and is employed for drawing the soffit lines of straight arches: when the other edge is curved, it rises only about one half of the other, viz. about half an inch in six feet, and is used for drawing the upper side of the arch, so as to prevent its becoming hollow by the settling of the arch. But some persons prefer having the upper side of the arches straight; and, in this case, the upper edge of the arch is not cambered. When the bricklayer has drawn his arch, he gives the camber-slip to the carpenter, who by it forms the centre to the curve of the soffit. The bricklayer, in order to prevent the necessity of having many camber-slips, should always be provided with one which is sufficiently large for the widest aperture likely to be arched.

The knowledge and use of the 'Camber-slip' is all but lost to modern craftsman, yet was, and remains, vital to set out the camber and establish the soffit bevels on a camber arch. It is also needed by a carpenter to set out the timber 'turning piece' over which the arch is constructed. It is explained, in detail, in section 2.4.6.

The *Mould* is used for forming the face and back of the brick to its proper taper; and, to this end, one edge of the mould is brought close to the bed of the brick previously squared. The mould has a notch for every course of the arch.

This is describing what later becomes termed a cutting, or reducing, box. The 'squared' bricks are placed into this box, made up of a front and rear templet, and then scribed or 'tinned', removed for axing to shape, and replaced into it for abrading flat between these two opposing edges. Here Nicholson (1823, 389) is describing one for voussoirs.

The *Templet* is an instrument for taking the length of the *stretcher* and the width of the *header*, in building walls, &c

The *Brick-axe* is used for reducing or cutting off the soffits of bricks to the saw-cuttings, and the sides of the lines drawn by the scribe. Much of the labour required for rubbing the bricks may be removed by the axe being managed with dexterity.

The early brick axe (examined in section 2.1.6) is clearly not that shown in Nicholson's fig 2. The stated use of it, for 'cutting off the soffits to brick to the saw cuttings, and the sides to the lines drawn by the scribe', is revealing. This brick axe is considerably bigger and heavier. It had narrow 3 inch (76 mm) blades, 25½ inches (645 mm) in total length, with a similar sized grip to that shown by Moxon, but it weighed about 6¼ lbs (2.83 kg).

These sizes and weight are taken from Lloyd (1925, 289) where he reproduces a photograph of the two different types of brick axes placed side-by-side with their respective details recorded beneath. This later axe being large and heavy, was not intended for fine shaping, its size negates such use. It was designed to cut as large a waste portion of brick as possible, something which was important because of the large amounts of 'axing' (or cutting) of brick arches in the cutting shed.

Lloyd (1925, 72-30) quotes the larger brick axe in use from *The Dictionary of Architecture*:

...The lines having been first marked on the brick by a species of small saw, the axe is then taken by the middle and held in a perpendicular position, its edge is then applied to the brick where marked, and both being raised together, it is struck smartly on a block of wood, by which the brick is cut into shapes. The rough edges of the brick are then rubbed on a piece of grit stone.

This definition reveals the changed use of the tool. Clearly its long chisel-type blade design and heavier weight was intended to 'cleave' bricks in a manner akin to a chopper splitting timber. This brick axe is incapable of trimming and dressing rubbing bricks as its predecessor.

A large brick axe was forged, by a traditional blacksmith, as part of this research programme, following the exact specification given by Lloyd, and used in a series of trials to determine its performance in the manner described above.

These trials were carried out using different rubbing and soft handmade bricks, using a grub saw and a chopping block of 75 mm thick timber. The intention being to determine the practicality of the above quoted axing technique, assess the overall effectiveness of the brick axe, and finally judge the speed a hewer could both cleave a brick to shape and rub its surface flat.

In all tests the grub saw was used first to cut a 6-10 mm deep groove all around the brick, defining the waste portion to be cut away. Stood upright on the chopping block, the brick axe blade was then located centrally into the saw cut on the brick. Initially it was noted that the sharpened end of the brick axe blade was only penetrating about 2 mm into this cut because the bevelled edge thickness (5 mm) of the brick axe blade. The blade was 'shouldering' and not fully entering the saw cut. It was decided to proceed. With the brick held by the left hand and the brick axe held vertically with the right, the two were raised simultaneously about 50 mm off of the chopping block and brought down smartly upon it.

The results were most revealing. With modern harder rubbers, the brick axe simply 'cleaved-out' sizeable chunks of material, failing to cut through the brick from top to bottom, or from side to side. The inability of the axe blade to sit deeper into the cut was deemed partly responsible for this, but it was felt that the major factor was the harder modern brick.

This latter opinion was subsequently confirmed when tested on softer, more traditional, low-fired rubbing bricks, which the brick axe split accurately in one go, leaving a reticulated surface that 10-15 seconds on the rubbing stone rubbed flat to line. Nicholson advocates the use of sand to aid abrasion if the rubbing stone is working smooth. Though not unacceptable, dry silver or fine loam sand would be necessary to avoid scratching the brick faces. Of particular importance was that the ends of the bricks, impacting the timber chopping block, in this cutting process, were not damaged as anticipated, thus allowing them to be squared or bevelled as their intended use demanded.

Peter Hill, who had never seen such an 'incongruous cutting tool' before, made the following comments on the large brick axe, after cutting with it (Hill, 2000):

It is clearly very unsatisfactory for dressing bricks owing to its size and weight. It seems rather elaborate for splitting bricks. The final trial with the tool did show that it could be used to split soft rubbers quite satisfactorily. With this tool in one hand and the brick in the other, however, there is no risk of the two halves of the brick falling after splitting, which would risk breaking them.

The brick axe blade was subsequently thinned at the ends so it located more effectively into the saw cut, further improving its effectiveness. It also confirmed this was a quick and efficient method to cut off brick waste and rub smooth, very important in a busy cutting shed where hundreds of bricks needed quick shaping prior to finishing (or moulding) for the many gauged arches dominating numerous brick facades.

2.4.5 Gauged Enrichments

The brickwork of this period was at first a consolidation of the fine work of the post-Restoration period. This was especially true of gauged work in the early part of the eighteenth century, which continued to be employed to great artistic effect through the personal input of artisan architects and master bricklayers. Later, as the century progressed, its use became increasingly tame and style-bound, as the period settled into a rigid architect-led, or pattern-book copied, conformity, revealing the all-important loss of craft input. Importantly, with this change, bricklaying began being viewed no longer as an 'art', but rather as a 'craft' where craftsman were losing intellectual and creative input in the design and creation of his work.

2.4.6 Gauged Arches

At the beginning of the period the flat or 'streight' arch became unfashionable and around 1710-30 the segmental arch dominated, occasionally challenged by the semi-circular or semi-elliptical arches (preferred for doorways), and occasionally the Queen Anne and ogee.

No matter what shape was used the basic cutting techniques for the bricks remained the same, and it was here, in the cutting shed provided for this purpose, that the old-time bricklayer jealously kept from his less fortunate workmates the art of cutting and gauging the arch.

Initially the arch had to be drawn out, full-size, so templets could be obtained. In general, only half the arch needed to be drawn, as the other half was a mirror image. Also from the drawing the exact number of voussoirs could be determined, the size of joint, the soffit bevels and the correct curve to the extrados of the voussoirs.

The setting of a gauged arch could be accomplished in different ways according to the situation and number of similar arches needed on a job. If the arch were large or with voussoirs having each soffit bevel of a different shape like Queen Anne arch, then they were often assembled in small sections in the cutting shed and then joined together to complete the arch over the opening. If the facade of the building had many similar arches, as was common, then all the arches might be complete assembled inside wood jigs. These were then raised into position over the openings for which they were ultimately intended. The jig was left securing the arch until it was bonded with mortar into the face: the technique resembled that of the modern lintel, in that there was no delay on the progress of the building while the arch was constructed *in situ* and hardening.

Generally though the method most favoured was to construct the arch *in situ*. In this instance the temporary timber support, or centre, was checked for position, level and plumb, and then the intrados position of the voussoirs were obtained from the full-size drawing and marked out upon the support. Lines were then erected across the opening where the arch was to be turned from the main walling to ensure the arch would be constructed flush. Also a line, or a thin batten was fixed to the radius, or striking point, of the arch centre to check that the joints were normal to the curve and that the extrados height was maintained.

The arch was then 'turned', or constructed, working evenly from either side of the opening, keeping the previously laid voussoirs damp and finishing with a key brick at the top or middle of the arch. The key brick had to be carefully dipped on either bed into the preferred greystone (hydraulic), lime putty: silver sand mortar, and quickly lowered tightly into position. Once completed, some craftsmen asserted that it was best to slightly 'ease' the turning piece or centre so that the bricks took up their bearing and locked tightly together. Upon completion of the gauged arch it was made secure by filling joggle joints, cut or filed into the opposing voussoir beds to create a channel, with a hydraulic lime grout. The cleaning of the arch face and soffit was normally left until the whole building was completed.

Some arches like the camber and Venetian wave had a different shaped voussoir for each position, every brick having a different bevel. This would only apply to one half of the arch, as each voussoir would have its mirror image in the other half. Therefore it was necessary to number each brick related to its position and indicate its side and to set the voussoirs out on the scaffold in order of use.

When one is discussing gauged arches the camber or flat arch deserves an individual mention. This arch was widely used yet was considered the most difficult to set-out and construct correctly. The camber arch, though highly favoured, was generally a weak form of construction, hence they were generally only a half-brick in thickness with a timber lintel at the back. They were sometimes used over a large opening, however they were best limited to a span of 1.3 m. In essence the camber arch cannot truly be classed as an arch but as a scheme for spanning an opening.

It is interesting to note that for the 'Strait' [straight or flat] arch, Neve, (1726, 10) states:

These Arches commonly consist of a stretcher, and a header in height, the stretchers being a whole Brick's length, and the Headers a Brick's breadth.

Study of Batty Langley's own figures (Figure 57), depicting the accurate bonding of a facade and arch in his 1749 edition of *London Prices of Bricklayer's Material and Work*, show both straight arches not half-bonded, but quarter-bonded. The stretchers are cut with dummy joints to create closers next to the headers.

Generally arch bonding followed the rules of the popular Flemish bond at the quoin, bonded stretcher, header followed by header, closer and stretcher (a three-quarter bat). Bond at the springing was normally dictated by placing a stretcher in the lowest position at the centre or key on the arch face.

Langley has an error of scale in his *Fig 1*. by placing closers in each course of voussoirs of the straight arch, which only has a face height of four vertical courses. As he does not create the closure by a dummy joint in the stretcher but places it next to the stretcher, the resultant space left for the header would in reality only allow a closer. This is incorrect. One can only bond with a closer in each course when the arch has a face height of five vertical courses - normally 13¾ ins (350 mm), or 15 ins (380 mm) as in his *Fig II*, and as shown in Figure 58.

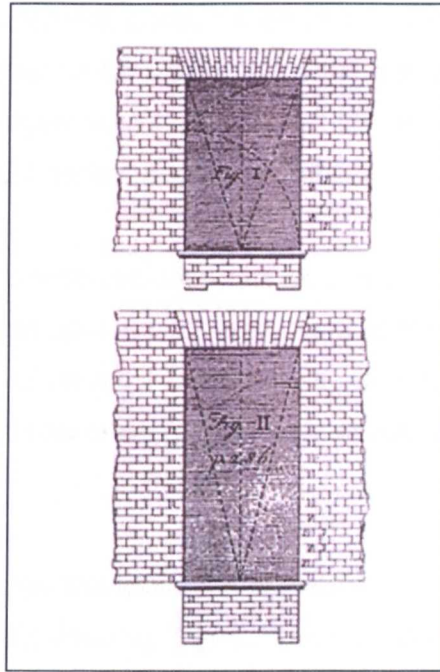


Figure 57 Setting out the splay of a straight arch and quarter-bonding the arch face, as depicted in Batty Langley's 'London Prices Of Bricklayer's Materials and Work', 1749.

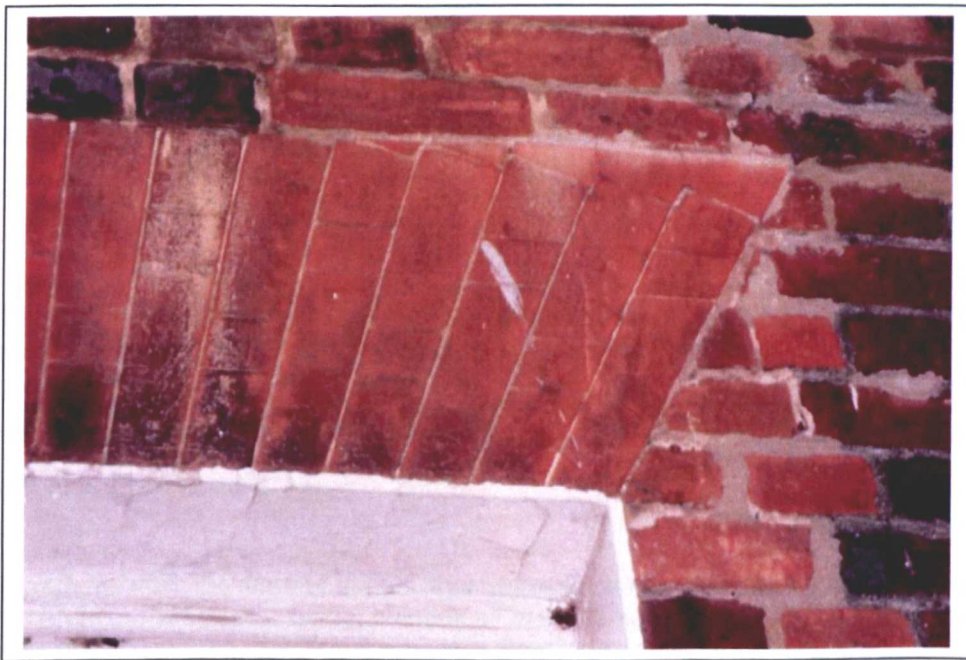


Figure 58 Straight gauged arch with a face height of five vertical courses showing closers in alternate courses of the arch voussoirs.

Observers are frequently mystified as to the reasons for the small sections of cut bricks above the horizontal cross-joints of stretcher voussoirs, on either side of the springing of an arch. The explanation is simple. Springing bricks in a flat, camber, or indeed a

Queen Anne arch are the longest in terms of their overall voussoir length, as opposed to the 'key brick', which is the shortest. When setting out arches to establish individual templet lengths, given that rubbers were the same size as standard bricks, it was impossible to cut the longest voussoirs from full-size stretchers. To use a craft term, the bricks would not 'hold-out' to the required length.

The problem and one common solution can be explained as follows. The prepared stretcher would be placed upon the full-size drawing to extend sufficiently below the intradosial line in order to allow the brick to be scribed to its bevel, or soffit. The brick was then cut with the tin saw leaving it correctly angled to its radial position; a process known as 'soffiting'.

This would, however, leave the top of the brick down from the set-out voussoir position and length on the working drawing. The portion that had been sawn off the bottom of that stretcher voussoir when 'soffiting' was turned over and, with or without adjustment placed to the top of that voussoir. This works perfectly as the bedding angle to extend the voussoir and meet the horizontal cross-joint as drawn is identical. This joint was then 'blinded-out', by deliberately rubbing into it damp brick dust during rubbing-up. The deceit only becomes visible when, with weathering, the joint is exposed.

Concern for structural weakness of straight, or flat, arches was discussed by Neve (1726, 10-11):

Theorem the 2d Bricks moulded in their ordinary Rectangular Form; if they be laid one by another in a level row, between any Supporters fultaining their two ends then all the pieces between will neceffarily fink even by their own natural Gravity...

Emphasising how it is strengthened if curved, an early indication of the need to camber the soffit of a straight arch, Neve continues:

Theorem the 4th If the Materials figured Wedge-wife,... fhould be difpofed in the Form of fome Arch, or Portion of a Circle, pointing all to the fame Center, in this cafe, neither the pieces of the faid Arch, can fink downwards for want of room to defcend....

By the middle of the eighteenth century, a cambered soffit to a straight arch was accepted good craft practice and Pain, (1769, 11) gives the measurement:

The soffits of the arches ... to camber an $\frac{1}{8}$ of an Inch in a Foot, that is $\frac{1}{2}$ an Inch in 4 Foot &c.

This measurement of $\frac{1}{8}$ inch to a linear 12-inch run of span remains the accepted camber today, now given as 3 mm per 300 mm. Yet this was not purely for structural reasons, if these arches were set with the soffit perfectly level, they appeared to sag in the centre. To overcome this illusion they were given a rise of 3 mm to 300 mm of span; it was from this action that the term 'camber arch' arose. In some Eighteenth century books it was also suggested that a rise of half that to the intrados, could be given to the extrados, but this was not a common practice.

To draw such a shallow rise across the opening would be impossible from a trammel or 'radius rod' as it's 'striking point' would be far off. The method adopted was to use a length of specially-shaped timber termed a 'camber slip', made from a length of mahogany or oak, which would not shrink or twist, about 300 mm longer than the widest opening expected and so convenient for all spans of arches. Richards (1901, 57-58), though writing later, gives an explanation of the camber slip and its use (Figure 59):

The mode of obtaining the camber slip is as follows (an extreme case is given, as being easier of illustration): Suppose the opening to be 3' 0", and the rise 1" to the foot, then the camber slip 3' 0" long would have a rise of 3"; take a rod 3' 0" long, measuring in width 1" at each end and in the middle $2\frac{1}{2}$ ", or, in other words, having in the centre half the required rise; shoot this piece from the middle to the two ends perfectly straight, thus forming two triangles, as it were, upon a common base; call the centre **B**, and the two outside points **A** and **C**.

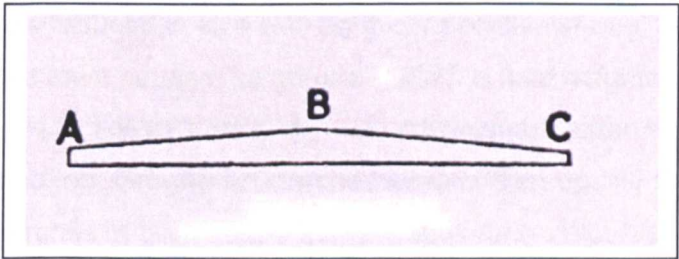


Figure 59 Camber slip.

Then take a piece of board a little over 3' 0" long and $6\frac{1}{2}$ " wide by $\frac{1}{2}$ " thick, planed both sides, and one edge shot [planed true], draw a centre line upon the face of it, and 18" each side of it draw two other lines; call the centre line **E**, and the two outside lines **D** and **F** [Figure 60].

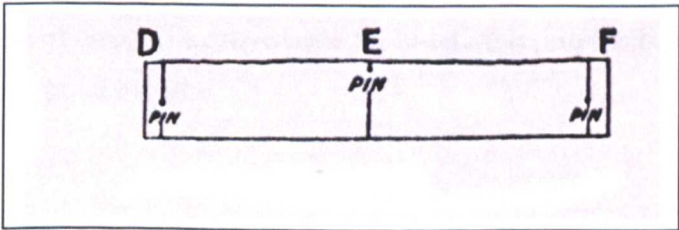


Figure 60 Camber slip.

Upon the centre **E**, 6" up from the shot edge, drive in a pin, and upon **D** and **F**, 3" up from the shot edge, drive in other pins. Then take the first piece (fig. 153), already prepared, and with a pencil held at the centre **B**, apply it to pin **F**; and with **A** on the same piece pressed against the pin **E**, move the piece with the pencil from **F** to **E**, describing half the curve. [Figure 61].

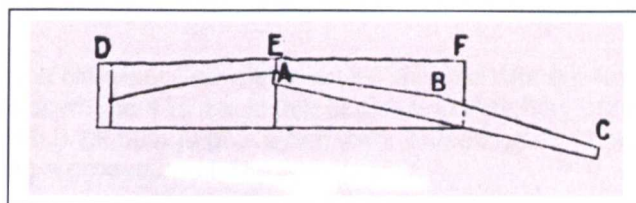


Figure 61 Camber slip.

Repeat this process on the other side, moving the centre **B** with the pencil from **D** to **E**, and the curve will be drawn; then cut the curved side to the line drawn, and the camber slip will be completed. To prove the camber slip, lay it down and mark all round it, then reverse it, and if the camber slip coincides with the lines drawn by it, it will be correct. In using the camber slip always work from a centre line.

The emergence of the camber arch is contemporary with moving timber frames back from the face of the brickwork of the window and door openings, so removing the support the arches gained from them. It is also the time when one begins to encounter the use of rendered reveals and soffits to window openings, painted white to reflect light.

As window openings reduced in size with each consecutive storey, especially on the fashionable terraced town houses, so generally did the face heights of the flat/camber arches also, from $1\frac{3}{4}$ to $1\frac{1}{2}$ to 1 brick high respectively; and often the quality of execution diminished too. Ground-floor arches were of best quality rubbers set finely gauged; first-floor arches of good rubbers - not necessarily colour-matched - set with slightly thicker joints; and at the top floor, utilising the lowest grade of rubber, as an axed arch.

In order to effect the appearance of gauged arches of red rubbers when buff-coloured bricks were used, arches would be colour-washed to the desired hue. Another practice to create the illusion of gauged work, where an axed arch had instead been constructed was to 'tuck and pat' point its face.

There are also instances during this period when mathematical, or brick, tiles were introduced and employed on some properties, where they were used for flat gauged arches over window heads. O'Shea (1981, 14), commenting on their use in Lewes (Sussex), records:

These are made in the classical Georgian manner with red rubbers worked to tapering voussoirs, but sawn down the $4\frac{1}{2}$ " thickness to give two matching bricks and ends of the bricks dry rubbed with brick dust to give a butt joint. The staggered horizontal dummy joints are formed by cutting a groove and filling with mortar.

The angle of 60° remained the ideal skewback. Study of Batty Langley's plate of the two straight gauged arches (1749) (see Figure 56) reveals another common bricklayer's practice of placing the 'striking point' along the vertical centre line at window cill level; regardless of the height of that opening. This gives Langley's fig. I a 70° skewback, whereas his taller fig. II has a much steeper angle of 76° .

Yet another method, long accepted and practised by craftsmen bricklayers, is the One Third Rule, as explained by Nicholson (1823, 352-3):

The proper method of skewing all camber arches should be one-third of their height. For instance, if an arch is nine inches high, it should skew three inches; one of twelve inches, four; one of fifteen inches, five; and so of all the numbers between those....

Using this method a consistent angle of 70° is achieved for all skewbacks, no matter what the face height of the arch is.

Occasionally flat/camber arches were produced with very acute angled skewbacks, between 30° to 45° , would be used. This would appear to have its origins in the fashion for the Queen Anne arch, popular during the Palladian period in the first 60 years of the eighteenth century (Figure 62).



Figure 62 Two Queen Anne, or Venetian Wave gauged arches to the later rear elevation of Aspley House, Aspley Guise (Bedfordshire), c.1740.

Visually a peculiar arch, it is struck from three centres and has the appearance of a camber arch intersected by a semi-circular arch. Structurally weak, it is usually supported on piers, or columns, placed either side at the intersection of the flat and semi-circular construction.

Acute-angled skewbacks on flat or camber arches are not only visually disturbing, but they also contribute weakness to the arch, particularly on wide spans, reducing their effectiveness in being strong enough to accept, resist, and discharge the thrust brought to bear upon it from the loading above. On the majority of such arches there are frequently cracks to either side of the arch face directly up from the jambs, due to the stresses created in the haunch or shoulder of the arch as the unsupported central area of the arch is forced down.

Though it is never stated in any craft books, it has always been accepted best practice to set the first or 'springing' bricks on either side of the arch from their skewbacks with

the same size putty joint as the rest of the arch. Frequently this is not attended to, a larger bed joint of front mortar being used instead, seriously detracting from the precision and appearance of the gauged arch. Cutting skewbacks either to radial string lines, or using fixed wooden guides (guns) the angle must always be precisely cut and maintained throughout its full length. It must also be perfectly flat across the full depth of the cut surface in order to take the fine joints of the springers. This is why many skewbacks are frequently constructed of the same rubbers as the arch - though laid as standard facework - as they cut easily and accurately (Figure 63).



Figure 63 Skewbacks cut precisely from rubbing bricks laid in standard or 'front mortar' to facilitate a tight putty joint at the springing point.

In concluding this examination of gauged camber arches, and concentrating on constructional faults, Nicholson (1823, 352) highlights a poor craft practice responsible for a common construction defect:

...the faults alluded to, are the bulging or convexity in which the faces of arches are often found, after the houses are finished, and sometimes loose in the key or centre bond. The first of these defects, which appears to be caused by too much weight, is, in reality, no more than a fault in the practice of rubbing the bricks too much off on the insides; for it should be a standing maxim (if you expect them to appear straight under their proper weight) to make them the exact guage [sic] on the inside, that they bear upon the front edges; by which means their geometrical bearings are united, and all tend to one centre of gravity.

This practice has been encountered on many occasions whilst repairing defective gauged work; and it is not reserved only for arches. On some ashlar walling the bricklayers would frequently rub more off the top and bottom beds towards the back of each brick, so that, in taking an on-end view of the brick, one finds some resemble a cone shape. The difference from the measurement of the overall face gauge to the rear of some of these bricks can be as much as 10 mm (i.e. 5 mm) being rubbed off either

bed. This bad practice is not confined to English gauged work, but is seen also in Flanders and the Netherlands. The loss of brick was typically made up with a trowel-applied mortar, to a stiffer consistency, allowing the brick to be manipulated more easily to line and 'face plane'. This was not a good practice, as it reduced the effective load-bearing area, especially where there were voids or mortar shrinkage so concentrating it towards the front edges and leading to bulging and loss of overall wall strength.

2.4.7 Gauged Niches

In thick walls of many mansions and public buildings, circular recesses, or niches, were occasionally formed. A niche, from the Italian 'nicchio' meaning 'shell', was usually semicircular or semi-elliptical on plan and covered with a semi-dome of the same character built in gauged brickwork. The origin of the niche is rather obscure and though it is not uncommon to see them empty, there seems no doubt that they were originally designed to house statues or other works of art.

A niche had little to do with the general stability of walling, as it was simply decorative, yet it still had to be constructed carefully so that it did not weaken the wall. The lower part of the niche is called the 'body' and its upper part, the 'hood' (Figure 64).

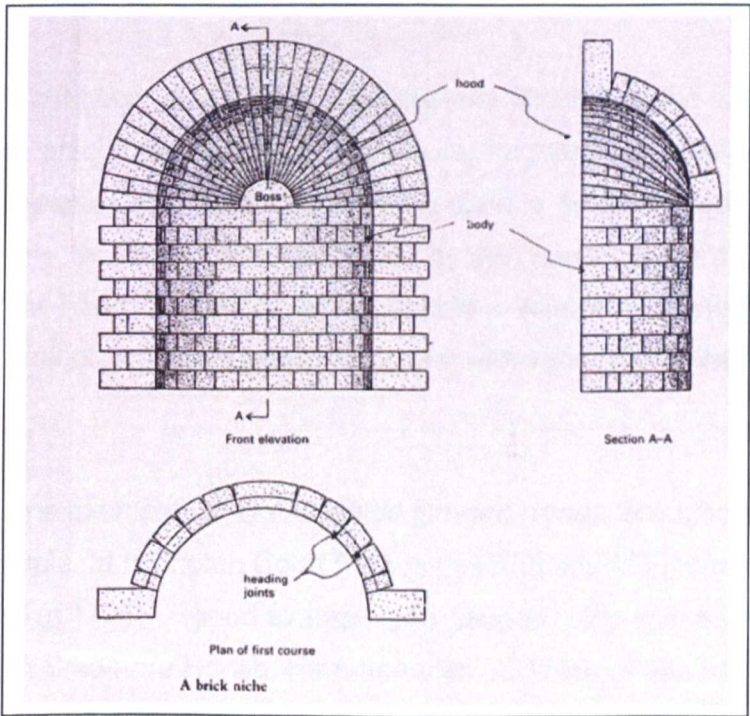


Figure 64 Drawing of a gauged niche depicting its parts.

The construction of a gauged brick niche, an area of craft work termed 'circle-on-circle', has always been considered to be one of the most artistic pieces of work in connection with their craft and the supreme test of a bricklayer's skill as a craftsman. It not only draws on excellence of manual dexterity, but also sound knowledge and application of geometry. Without these attributes it would be impossible to set-out, cut, and construct a niche.

It is in the design, execution, and finished appearance of the wonderful specimens of gauged brickwork niches from the post-Restoration and early Georgian periods that one determines the depth of the Dutch influence on this branch of the craft. Amongst the early seventeenth-century 'gildeproeven' masterpieces of 'geslepen metselwerk' – gauged work in De Waag, Amsterdam, are several fine examples of gauged niches. These are either to be found as full-depth, or shallow-bodied niches, constructed of orange/red rubbers and set in fine lime putty: silver sand mortars, with joints that range from 0.5 to 2 mm in width.

Their construction follows a similar theme of squared or 'mop-staff' cut-moulded jambs, or alternatively with cut-moulded architraves leading into the curved body of the niches. The body of each niche is terminated with projecting plain or cut moulded 'necking' courses on which rest the 'hood', set-back to follow the line of the body. The hoods are all constructed of radial voussoirs to follow the bond and detailing of the body.

It is impossible to cut hood voussoirs to the wafer-like thinness at the extreme of the striking point from which they all radiate. A brick (or frequently several courses of set bricks) is thus shaped as a miniature hood and rubbed to the same curve. This element, 'boss' - is frequently, though not always, set-out by the rule of one-third of that of the overall radius of the hood - and all voussoirs abut to it. Almost all of the De Waag bosses have a small projection to facilitate carving with variations of the scallop-shell motif.

There are many fine examples of Dutch-styled gauged niches throughout southern England, for example, at Hampton Court Palace (c.1690) and at Finchcocks in Goudhurst (Kent) (c.1725). A good example of a gauged niche with a carved boss is one originally from Bradmore House, Hammersmith, (c.1700), which has been re-erected in Geffrye's Garden at the Geffrye Museum, London, where the delightfully carved boss is particularly worthy of note. This niche, like that for the Eltham Orangery

in London (dated c.1710, with the boss carved as a scallop-shell), have both undergone successful conservative restoration under the guidance of the author.

Normally the gauging of the niche hood is more accurate and finely set than the gauged work of the body, though an exception to this rule is to be found in the niches at Chicheley Hall (Buckinghamshire) of 1723. The two niche hoods at Mottisfont Abbey (Hampshire) of 1836 are also particularly worthy of note, being of superior quality of clean-bodied rubbers neatly wrought with a most wonderful carved boss, displaying the main brickwork tools used to set-out and cut the niches (Figure 65). The bodies are of low-fired face bricks, cut and rubbed and exposing their inclusions so rendering them incapable of the fine cutting necessary for the hood, set to a standard gauge, and pointed flush with a pigmented mortar to reduce the impact of the wider joints.

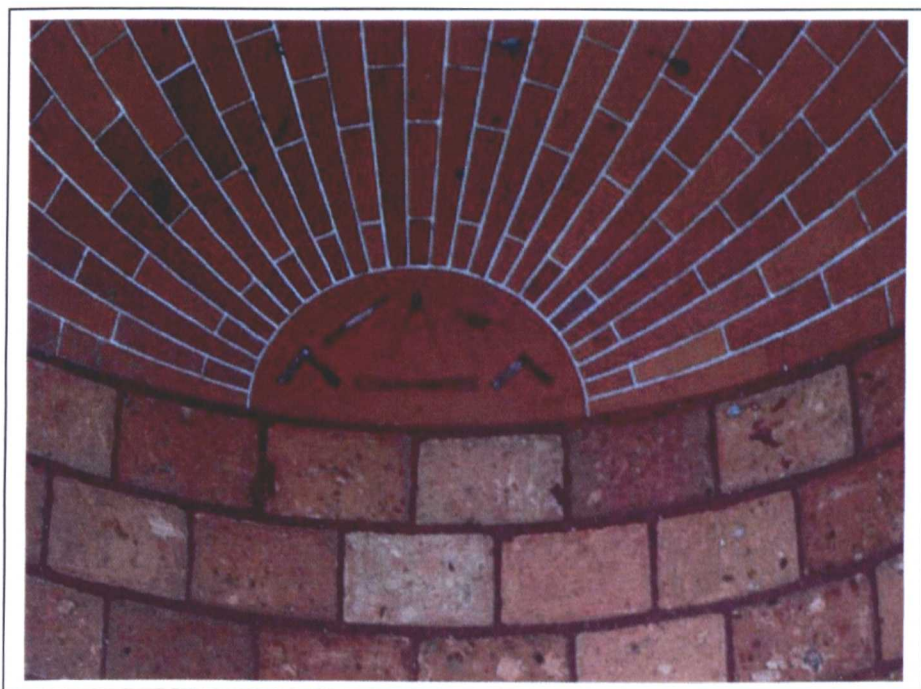


Figure 65 Gauged hood with carved boss in a body of cut and rubbed standard bricks at Mottisfont Abbey (Hampshire), 1836 (Ian Hamilton).

Study of these and other niches reveal first how they have to be considered in two parts, the body and the hood, which were always set out and cut as two distinct and separate operations. Secondly that the hood needed to be more accurately set-out, cut and constructed to maximise its strength to accept and transmit the masonry directly above it.

2.4.8 Niches with Horizontal Hood Courses

Occasionally niches were constructed with horizontal hood courses continuing on the bond of the body, almost always when it was intended to carve *in situ* a major part of the hood; a craft practice that appears to be uniquely English.

When executed, the hood brickwork was either bench-built in the cutting shed and set into position, or laid *in situ* across the opening on a temporary timber support to create what is termed a brick 'lump'; with fully-filled joints so none would work hollow with carving. A wonderful example of this form of carved niche head construction is Helder's (re-built) masterpiece in the Victoria and Albert Museum (Figure 66). Also the large central niche of his (re-built) frontispiece originally from Christ's Hospital School, London, now re-erected at their Horsham campus in West Sussex (Figure 67).



Figure 66 Carved 'Amorini' to the niche hood of horizontally laid gauged work 1675, (by courtesy of the Board of Trustees, Victoria and Albert Museum, London).



Figure 67 Carved niche hood of horizontally laid gauged work, Christ's Hospital School, Horsham (West Sussex), c.1672. (Mark Haskell)

The construction of these niches generally reveals hood joints of approximately 0.5 mm in thickness, in contrast to the, still fine, average of 2 mm thickness to the niche body. This is due to the lumps being constructed in either hot or cold 'cement' (see Section 2.3.5). Later in this period, however, a white lead and shellac matrix was beginning to be used as well, both facilitating close and unbreakable jointing. By mixing dust from the rubbers being cut for laying in these 'cements', the joints could also be effectively 'blinded-out' so reducing visual disruption to the appearance of the carved hood.

Despite the fact that the joints were so finely set and possibly 'blinded-out', the bonding of these lumps still called for considerable forethought and ingenuity on the part of the craftsmen to avoid exposure of the vertical cross joints where carved back. The carving of the hood, and indeed all gauged enrichments, was essentially the preserve of the 'trade carver'. The trade carver was a most prestigious artisan and high skilled craftsman with whom the virtuoso bricklayer enhanced many an ambitious facade. The carving was executed with soft stone tools and a wood mallet. These tools comprised chisels, gauges, files, drills, conduits, and so forth, and were of a variety of shapes and materials, as these bricks were delightfully easy to work.

A dried-out plant called 'Dutch Rush' was still used extensively during this period until the advent of modern sandpapers, for abrading surfaces. Also known as 'Shave Grass',

'Pewterwort', or 'Scourwort', it is a primordial plant that grows in sandy soil. Feeding through its root system, it draws up silica in nutrient form eventually forming a fine glass paper-like surface on the leaf. Carvers, like Grinling Gibbons (1648-1721) used 'Dutch Rush' which abrades particularly strongly when worked sideways, frequently leaving its tell-tale striations; especially noticeable in areas having restricted access.

Taking into consideration the nature of the rubbing brick, when carved it was considered good practice not to so undercut it as to leave half a brick unattached. Although the white lead and shellac, (or other craft 'cements'), made an ideal 'iron hard' adhesive, it would have been foolish to expect an exposed over-hanging part of a rubber to withstand our British climate for long.

To prevent damage by the elements all the top edges of the external carving had to be 'weathered', that is rounded, or sloped away, so as to throw off the rain. Recesses or hollows where water could collect would lead to frost 'blowing' any projections. The upper surfaces of most upper projections were generally protected by a lead flashing to prevent saturation of the carving, which would most certainly have led to a rapid deterioration.

Summary

The Georgian period was a consolidation of the fine gauged brickwork achieved in the late seventeenth century, though its use became less adventurous as the neo-classical architects, rather than the master bricklayers, designed the features. After the Great Fire the return of country bricklayers to their native shires allowed their assimilated skills and knowledge of gauged work to spread out beyond the confines of the London and its craftsmen. This facilitated all improvement in national brickmaking and bricklaying and it witnessed quality brickwork with fine gauged work dressings as an almost ubiquitous feature of every brick-built Georgian town and country properties.

2.5 THE VICTORIAN AND EDWARDIAN PERIODS (1837-1914)

Historical correctness should dictate that these adjoined periods terminate in 1910, with the death of King Edward VII, but these are generally accepted to extend to the outbreak of the Great War of 1914.

The accession of Queen Victoria in 1837, coincided with the dawn of a dramatic period of national inventiveness, development, and prosperity, unequalled in the history of the world. A long period of peace, following success in the Napoleonic wars, allowed Britain to concentrate her energy and wealth on industry; it was her 'Golden Age'.

The architecture of previous centuries generally continued to evolve slowly along traditional lines, but this changed enormously, with attendant social consequences, with the huge material expansion facilitated by the discovery and use of steam, gas, and electrical power. In architecture the conflict between the traditional past and a new Industrial age, manifested itself in the so-called 'Battle of the Styles'. This was a period in architecture of revived vernacular styles often striving for a return to 'medievalism', rusticity, and other traditional building forms as a relief from what was seen as the hard functionalism of the machine age

The fashion for stucco, especially during the Regency period (1800-30), saw standards of brickmaking, the quality of mortar, and the brickwork constructed, reach a nadir; encouraged by unscrupulous and largely unqualified builders. This was not resolved until the collapse of several buildings during the course of erection and the resultant Building Acts of the 1870s. Although the fashion for face brickwork returned after 1840, gauged work had been a major casualty.

Within architecture the classical style dominated for public buildings such as libraries and museums, based on Greek and Roman originals. The Gothic Revival was foremost in the move against the prevailing use of this style, and later the hugely influential Arts and Crafts movement, founded by John Ruskin (1819-1900) and William Morris (1834-96). Both were authors, artists, and philosophers strongly influenced by Augustus Pugin (1812-52) who, as a devout Catholic convert Christian, advocated the strict design philosophy of the Gothic Revival.

Ruskin published *The Seven Lamps of Architecture* and *The Stones of Venice* between 1849 and 1853 arguing that the beauty of architecture was a result of sincere use of materials and honesty in construction. In this respect, Ruskin proposed that the right Gothic style was the north Italian or Venetian Gothic, and that the use of its polychromatic, multi-coloured masonry should be from the natural hues of the bricks and stones, not paint or other superficial applications.

Though there were elements of opinion in the Gothic Revival that preferred stone to brick, some proponents used brick, especially traditional handmade bricks to exploit the artistic possibilities of gauged work, as at The Midland Hotel, St Pancras Station, London (1868-74) by Sir George Gilbert Scott (1811-78).

The vision of the Arts and Craft movement was a return to the virtues of freely expressed craftsmanship that were, it was thought, being destroyed by mass-production and the economics of capitalism. One answer was found in the so-called William and Mary and Queen Anne styles, popularised by architects such as Philip Webb (1831-1915), William Eden Nesfield (1835-88), Richard Norman Shaw (1831-1912), John James Stevenson (1831-1908), George Fredrick Bodley (1827-1907), Edward Robert Robson (1836-1917) and Basil Champneys (1842-1935). All studied the older English use of hand-made, mainly red, bricks and based their designs on traditional methods, in attempts to restore bricklaying as an art and prevent its demotion to craft status. They did so by the prolific use of gauged work to wonderful aesthetic effect; though by their direct control over the designs they unwittingly prevented their overall desire from being fulfilled.

From the 1870s until the end of the nineteenth century the Queen Anne style heralded a golden age of gauged brick architectural detailing, particularly, though not exclusively in London. It was exploited for arches, aprons, pilasters, consoles, carved capitals, cartouches, date tablets, and friezes; the craftsmen bricklayers relishing this long-awaited opportunity to display their finest cherished craft skills.

Wonderfully ornate residences glorify our metropolis, such as the properties of the Metropolitan Board of Works estate of Chelsea Embankment, and Tite Street, and Cadogan, and Hans Place Estates in Chelsea of Cadogan Square and Pont Street, London. Sadly, the master bricklayers who worked on these properties are unknown, lost in the anonymous economic changes that saw their employers, large building firms,

take the credit for their work. The following companies are some of the most noted that worked on the above developments (Girouard, 1977, 228-9):

- Gillow and Company (contractors, Chelsea Embankment, 1876-78)
- Jackson and Graham (contractors, Tite Street, 1880)
- Kirk and Randall (contractors, Chelsea Embankment, 1878-79)
- Simpson and Sons (contractors, Cadogan Square, 1886)
- Trollope and Sons (contractors, Cadogan Square, 1876-86)
- Trollope and Sons (contractors, Pont Street, 1876-83)
- Thomas Pink and Son (contractors, Cadogan Square, c.1877-85)
- Thomas Pink and Son (contractors, Pont Street, 1876-77)

We must content ourselves that, at least, the fruits of the skilful labour of the master bricklayers in producing gauged work of the highest order - despite the best efforts of the German Luftwaffe and the equally destructive post-war planners and developers - are still to be seen and marvelled at.

Gauged work was still being employed as, later, the fashion slowly changed to the less exuberant Edwardian style, for finishing simple enrichments to principal elevations. This lasted until the outbreak of the First World War in 1914 (Figure 68).

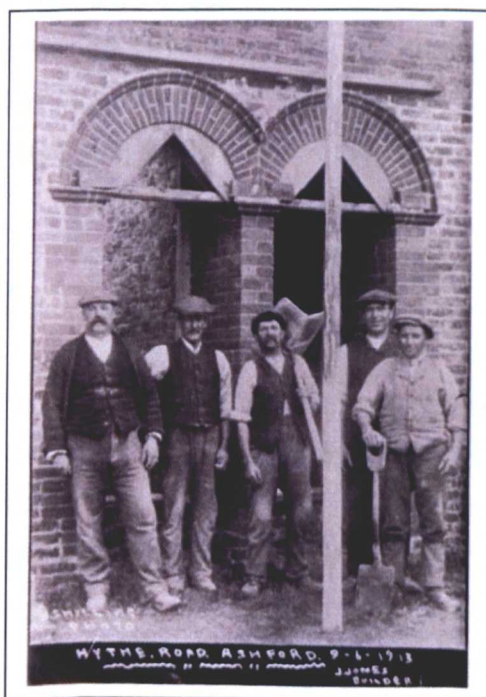


Figure 68 The end of an era - bricklayers and their labourers stand in front of recently completed gauged arches in Ashford (Kent), 1913, (Derek Seddon).

The eclipse of gauged work was due to several contributory factors, the decline of the large town and country house, expensive handmade bricks (up to three times the cost of those made by machine) and the increasing cost of labour. Labour-intensive gauged work priced itself out of the builder and client's pocket. A major factor, however, was the 1914-18 war.

A majority of Britain's finest craftsmen were lost to industry in the trenches, leaving an indelible mark on the quality of work that was to follow. A parallel can be drawn with the noticeable difference in standards of masonry work of mediaeval cathedrals and churches, left only part-completed when the Black Death struck. The loss of the finest skilled masons left their completion in the hands of semi-skilled people with neither the full knowledge nor skills to continue the high quality of work. So it was after the Great War. It was impossible to fill, and quickly train to the same standards, craftsmen to fill the huge void with so few young men remaining alive or uninjured. Only the youngest apprentice bricklayers, and their senior craftsmen - too old to fight - were left within the craft to learn from, and only a select few of the latter possessed the high-level skills, knowledge, and experience of quality gauged work. This was too great a blow for a bricklaying craft that, particularly in the last quarter of the nineteenth century, had invested so much in that fallen generation. It never recovered.

To give clarity to this loss, the census of 1911 gives 1,140,000 males as employed in building and construction. By 1921 this figure had dropped to 894,000 (Chadwick-Healey, 1971). Lloyd (1925, 27) gives union figures as '... there are now 36,000 bricklayers, as compared with 92,000 before the war...'.

2.5.1 Brickmaking

At the beginning of the nineteenth century the brick making process was still primitive. The urban pressure for quickly built homes for factory workers led to a massive demand for bricks. Between 1820 and 1850 over 100 brick making machines (Hammond, 1981, 14), and new-style, larger kilns were patented to take advantage of this lucrative market (Hammond, 1981, 23-24). Many new brickyards were located close to the new rail network to gain quick access to growing towns and cities and meet this unprecedented demand. Mechanisation in brick production, with steam engines gradually replacing men or horses, allowed new (harder and less plastic) sources of clay to be exploited from greater depths (Woodforde, 1976, 121-22).

To fully appreciate the huge demand for bricks during the last quarter of the nineteenth century, a report of a brickmaker's conference held in Southwark, London and reported in *The Builder* on 13th September states (1879,1033):

Some years ago a careful computation was made by Messrs Eastwoods & Co, of the quantity of bricks usually made to supply the markets of London and the metropolis. As near as could be arrived at at that time the numbers were found to be 600,000,000. But he had every reason to believe – and no doubt the experience of those concerned in the trade would confirm this – that in ordinary seasons the sale would be at 700,000,000.

A number of the larger traditional brickmakers with permanent brickyards and benefiting from rail access to London and other cities and towns began specialising in rubbing brick production. The majority of these, though not all, took extra care in the preparation of their own unique brickearth and clay, and in the firing of their bricks, to ensure a consistent quality of product essential for fine gauged brickwork detailing, by architects, and bricklayers. Searle (1936, 112) states:

Cutters and Rubbers are bricks which can readily be cut or rubbed to any desired shape and are used for gauged work, arches, and where a few bricks of special shape are required. Such bricks must be made of a very mild loam and they are generally made of a mixture of washed earth and sand. Unless a sufficiently large proportion of sand is present the bricks would not "cut" or "rub" properly and they would be difficult to make into the desired shape.

....They are dried and burned in the same manner as other bricks but care must be taken not to over-heat them or they will be useless.

As few natural materials are suitable, alone, for the manufacture of these bricks, they are usually made of a clay which is carefully picked, and run through a wash-mill into pits, where it remains until by evaporation and settlement it has attained a proper degree of consistency. The clay is then mixed with sufficient sand to diminish the labour of rubbing the bricks to gauge, the proportion varying according to the quality of the clay, but often being equal to that of the clay.

Gwilt (1888, 526) records:

The Red bricks derive their colour from the nature of the soil whereof they are composed, which is generally very pure. The best of them are used for cutting-bricks, and are called red rubbers...The Fareham Reds are noted bricks.

The Ballingdon or Ewell deep black rubbing and building brick, probably so rendered by manganese, are soft in make and dead in colour.

There is no naturally occurring brickearth or clay that will fire black rubbers, so deliberate adulteration of the clay was most likely out of a need for use in fashionable polychromatic work.

The yellow, or white, coloured bricks capable of being cut and rubbed were the malm cutters out of the London stock range, or from the calcareous clay reserves in parts of Bedfordshire, Hertfordshire, Norfolk, and Suffolk where, as stated earlier, they were known as 'Clippers'. Some were calcareous Cowley, Essex, Kent and Surrey bricks, such as those mentioned in *The Building News* of 8th May (1896, 667):

The Brockham Brick Company have some good samples of rubber, machine-pressed, and Gault facing bricks.

The malm or marl cutters, as referred to amongst brickmakers and bricklayers, were reserved for gauged enrichments. By 1850 the naturally fine, calcareous, malm clay was all but exhausted, so London Stock brickmakers had to specially prepare, wash, and strain their material in a creative process that became known as 'malming'; hence this definition of Malm cutters by Frost & Boughton (1954, 3):

...are a good uniform brick, light yellow in colour, made from a specially prepared clay, and are of a uniform texture throughout....Malm cutters or rubbers (seconds) are inferior to first-class malms ...in respect to colour which is not uniform as in the former case.

London building supply merchants trading out of riverside wharves were advertising malm cutters and rubbers in publications such as *The Builder*. In 1853 these included Henry Dodd and Co. of Hoxton Brickfields, and a Mr Benjamin Gough. In 1858 Charles Richardson (later A. & W. T. Richardson) of Brunswick Wharf, Vauxhall, was advertising rubbers and cutters '...of the best quality'. Later in the period other building supply merchants advertised bricks for gauged work, such as F. Rosher & Co. of Old Jamaica Wharf, who sold 'Yellow Malm Cutters' and 'White, Black and Red Rubbers'.

Advising on the selection of rubbers suitable for gauged work from a general firing of bricks, Hammond (1889, 78) suggests that:

... It is of very little use to look at the outside of a brick-stack if one is trying to ascertain the quality of the bricks.... The brick must be broken, or... sawn through with the saw, so as to examine the kind of earth of which it is made; for we frequently see bricks having a first-class appearance outside, and the inside when examined is found to be full of stones or clay that has never been properly worked up, much less washed; so that when the cutter begins to work he is sure to find one or the other defect just in that particular part which he wants to cut to the mould...

There would have been quite a number of small rural brickyards producing a variety of bricks capable of being rubbed. The following are among the companies marketing rubbers during the period:

- Allen's rubbers (Essex)
- Beart's white rubbers (Bedfordshire)
- Beaulieu whites (Hampshire)
- Chalfont red rubbers (Buckinghamshire)
- Collier's red rubbers (Berkshire)
- Cornard's rubbers (Suffolk)
- Cossey (Costessey) whites (Norfolk)
- Ewell rubbers (Surrey)
- Fareham reds (Hampshire)
- Kimber's rubbers (Hampshire)
- Midhurst rubbers (Sussex)
- Rosher's red rubbers (Suffolk)
- TLB red rubbers (Berkshire)
- Wheelers rubbers (Berkshire)
- Woolpit bricks (Suffolk)

Allen's Rubbers

R.H. Allen of Ballingdon (Essex, made a deep black rubbing brick sometimes referred to in contemporary documents as 'black Suffolk rubbers,' (this was due to the close proximity of the border separating Essex from Suffolk) as well as their dark and bright rubber range.

As Corder-Birch (1996, 446-7) records:

On the Essex bank of the river Stour at Ballingdon were the large brickworks of Robert Allen and Sons who excavated the Ballingdon Cut to facilitate access to their works by barges from the river. The river Stour has been navigable since July 1713... It therefore became one of the earliest rivers to be navigated... In 1859 Allen's were operating a fleet of 22 barges... Allen's Brickworks at Ballingdon had commenced in 1812 and they later owned another brickworks at Bures Hamlet. At their peak they were employing one hundred men in their brickworks.

Beart's White Rubbers

Robert Beart had huge rail-side brickworks exploiting the large reserves of gault clay at Arsley near Hitchin (Bedfordshire) Gwilt (1888, 526) states that his bricks were:

...of the following qualities, ranged according price:- white rubbers; handmade moulded solid brick, equal to the best Suffolks.

Frost and Boughton (1954, 60) record that 'Beart's Patent Bricks' are:

Made from a selected gault clay, They are hand moulded and kiln burnt, and of similar colour and texture to white Suffolks. They are generally known as white rubbers and used for similar purposes. They are made in two or three grades; the first or best quality for high-grade work. In actual construction a lime putty joint is suitable to the first grade of this brick....

Beaulieu Whites

These bricks were of a light straw colour, made from clay dug from the River Beaulieu near Southampton. The bricks for gauged work were more like cutters, being harder than a rubber. According to Cox (2003):

In about the 1840s, the Beaulieu brickworks at Baileys Hard, graded its bricks according to quality as best, seconds and thirds, while 'specials' were offered including splayed bricks, plinth bricks and 'saddle-back' copings. Rubbed bricks could also be supplied.

Chalfont Red Rubbers

Two types of rubbers, one dark and the other bright red were referred to by George Gilbert Scott in *The Builder* of 5th July 1856 (1856, 364):

A great deal might easily be done, not only with moulded but with cut bricks, of which some beautiful specimens might be found in the sixteenth century buildings about London. Bricks fit for this purpose could be obtained not far from the Metropolis, at Hedgerley and Chalfont.

In spite of research by the author, it has not proved possible to locate the exact brick yard or yards where the Chalfont rubbers were produced. It has therefore proved impossible to verify whether this production was at Chalfont St Peter or Chalfont St Giles, although the latter area, only a few miles from the village of Hedgerley, appears the most likely. Gilbert Scott in the above quote of 1856 mentions both Hedgerley and Chalfont rubbers in the past tense. Yet Messrs John and William Eastwood advertised 'Chalfont Dark and Bright Red Rubbers' for sale amongst their list of buildings materials in 1858 (Figure 69).

MESSRS. JOHN and WM. EASTWOOD
 are SOLELY engaged in the SALE of
 Messrs. R. A. ALLEN and CO.'s
WHITE and RED FACING BRICKS, and SHAPED GOODS,
 from their Ballingdon and Californian Works, near Sudbury, Suffolk ;
The EWELL deep BLACK RUBBING and BUILDING BRICKS,]
And the EWELL and CHALFONT dark and bright RED RUBBERS.
 And also SOLELY engaged in the SALE of
 Messrs. CALEB HITCH and CO.'s
YELLOW and PALE MALM CUTTERS and FACING BRICKS,
 and KILN GOODS,
 From their fields at Ware, Hertfordshire.
COWLEY and KENT BRICKS,
 in any quantities, by barge alongside.
 The usual commission allowed to merchants of the trade from the
 monthly price lists.
WELLINGTON WHARF, Belvidere-road, Lambeth ; and
KENT-ROAD BRIDGE.

Figure 69 Advert in 'The Builder' for 'Chalfont Dark and Bright Red Rubbers', 1858.

Certainly bricks capable of rubbing had been made in Hedgerley, near Windsor, for many years and are referred to as such by Nicholson (1823, 344). There is no reason to doubt that other suitable and exploitable sources of brickearth/clay were not also available in other parts of Buckinghamshire with prime access to the London market.

By 1881, trading as Eastwood and Company Limited, 'Lime, Cement and Brick Manufacturers and Merchants', are still advertising, 'Chalfont Red Rubbers' for sale, out of their four London Wharves. Gwilt (1888, 526), discussing the range of bricks available, also records:

...and Chalfont, supply dark and bright, red rubbers....

It would appear that Chalfont rubbing bricks, like those from other small yards, probably fell from popular favour with the rise and intensive marketing of larger and more powerful companies, like Johnson's and Lawrence's high-quality 'Fareham Red' and 'TLB' rubbers.

Collier's Red Rubbers

S. and E. Collier (Berkshire) were established in c.1848 and had various pits around the Reading area, including Coley Park, Grovelands, and Norcot Hill. They produced a wide range of fired-clay products including terracotta, roof tiles, and ornamental finials, as well as ordinary red sand-faced, moulded bricks, and red rubbers; although rubbing bricks do not appear to have been their speciality.

Cornard's Rubbers

From 1840 the Little Cornard Brickworks at Sudbury (Suffolk) was established by the Tricker family and, until the works closed in 1964, passed into other ownership several times. Working basic topmost clay, which contained a high proportion of flint that necessitated thorough washing and screening off into wash pits to mature over winter, they produced both red and white bricks. They also produced rubbers as purpose-moulded voussoirs in 303 mm, 355 mm, and 406 mm lengths. These required minimal rubbing to gain flat bedding surfaces and then cutting by what is termed 'topping and tailing' to suit the arch templet size and if necessary dummy joints cut-in if the arch face was to be bonded.

Cossey (Costessey) Whites

Costessey lies to the north-west of Norwich (Norfolk) the name being contracted by local pronunciation to Cossey. The pioneering female architect and wife of the owner, Lady Frances Stafford, started an estate brickyard around 1815 for the re-construction of Costessey Hall on a Tudor model (sadly demolished after the 1914-18 War). She worked closely with the leading antiquarian topographer, J.C. Buckler with the brickyard subsequently taken over by George Gunton.

Cox (2002) records that the works:

...produced 'Cossey Whites', actually a light yellow, which were widely used around the Norwich area... ... In the later nineteenth century, Guntons produced 'Costessey ware'.... Described as 'fine moulded brickwork which can be rubbed and shaped into intricate patterns' and they were used for George Skipper's office, 7, London Street, Norwich in 1896, which has ornamental bricks and Costessey Ware panels.

Ewell Rubbers

The Ewell brickyard was probably at, or near, the site of the Nonsuch brickworks between London Road and Vicarage Lane in Ewell (Surrey). According to Cox (2002), the brickyard:

Had its own clay pit and was in operation from about 1800... Originally operated by Swallow and Stone then Stone and Swallow and eventually Stone and Company.

The company produced Ewell deep black rubbing bricks, as well as dark and bright red rubbers. With regard to examples of the use of their black rubbers, Cox (2002), states:

In 1861 a house in Smithfield on the corner of St. John Street and Charterhouse Lane, London, the architect George Somers-Clarke employed Ewell black rubbers. In 1863 another building by Somers-Clarke, The Merchant Seaman's Orphans Asylum, Snaresbrook, used locally made red bricks which 'The Building' of 4/04/1863 p 242 described '...the fronts being relieved by black Ewell facing courses, and the window heads and other arches throughout are also of black Ewell cutters and red Ballingdon cutters'.

Fareham Reds

Fareham Reds were made in brickworks in the north-east part of Fareham in Hampshire, in the vicinity of Fareham Common and Fontley where the railway arrived in 1841-20 so providing valuable access to London by way of Eastleigh.

There is little doubt that the Fareham Red was considered a premium rubber during all of the Victorian period, as Walker (1885, 1761) emphasises:

Fareham rubbers for gauged-work also stand first in quality, though they are not extensively used, as they are dearer than the other varieties in the market.

Of red bricks Fareham Rubbers are the best; they are of a close, firm texture, will carry a sharp arris, and weather well; in colour they are cherry red.

The phrase 'carry a sharp arris' is worthy of greater exploration, as its meaning is frequently overlooked. Historic rubbers, dating from the fifteenth to the nineteenth centuries, are seen to be of close-textured body when cut. Most are easily cut and rubbed to give sharp arrisses; directly as a consequence of their integral material and manner of manufacture.

By 1860 excellent rail access existed eastwards too along the south coast to Brighton and the 'Direct route of Portsmouth to London via Guilford'. According to Cox (2002):

...in the 1860s and 1870s that 'Fareham Reds' came to prominence, to such an extent that Sir John Summerson suggests that 'Fareham Reds' seem to have been among the factors responsible for the change in the colour of London streets from brown to red in the 1870s. This type of brick was produced by William Cawte...listed [in the 1860s] at Furze Hall, Fareham, as a brick and tile maker.

On the subject of brick prices, *The Building News* of 8th March 1872, records (1872, 189):

Fareham Red Rubbing and Facing Bricks. - Price of the facing bricks in London is 63s. a thousand, 49s. Loaded in trucks at Fareham. Red Rubbers, £6 per thousand.

At about this time, Cox (2002) records:

...Cawte supplied Fareham Reds for two other major London public buildings. In 1871 he opened a new field adjoining his existing one ... to manufacture the 25 million bricks used in the construction of St Thomas's Hospital. And although G.E. Street's Law Courts (1874-82) is stone-faced to the Strand, Fareham Reds were amongst the large quantity of bricks employed throughout the building.

Fareham Reds were quickly taken up for more modest buildings in London. In 1873 the architect Richard Norman Shaw used cut and gauged Fareham Reds for the front of the offices in Leadenhall Street, in the City. He again used them for the Queen Anne Style Clock House, No. 8 Chelsea Embankment.

By the 1880s H. Johnson and Company owned the firm, their postal address being given as 'Lausanne', Fareham (Hampshire) and their manufactory address as Funtley (Figure 70).

M. JOHNSON & CO.,

Fareham-Red Ornamental and Moulded Bricks,

→ TERRA COTTA, &c. ←

THese GOODS are of a deep red colour, the material and workmanship is of the best possible description; the Bricks are used extensively by some of the most eminent Architects, and have been largely used in Churches and Public Buildings, which for durability and appearance are unsurpassed. "BRICKS" are the well-known "FAREHAM" colour. Most of the various Pattern Bricks are kept in Stock; if not in stock they can be supplied in about one month from date of order. In ordering Goods, please give as much time as possible.

ARCHITECT'S Designs carefully and expeditiously executed. Estimates given for Special Moulded Red Bricks, and Terra Cotta.

All Goods packed carefully in Truck or on Vessel. If Goods are required to be packed in cases, the cases will be charged for, and full price allowed when returned in good condition; all Goods put on rail at owners' risk.

TERMS:—Net Cash on 1st of the month following delivery.
 Cash with order for small parcels of Goods from Customers not having an account.
 N.B.—This Price List "cancels" all previous Prices.

PRICE LIST.

RED TERRA-COTTA FACING BRICKS	Price	52/6 per 1000
" CUTTERS for CARVING (large size)	As used at South Kensington Museum	100/0
" " " (small size)	&c., &c.,	80/0
FAREHAM-RED FACINGS, deep colour, selected		55/0
" " " medium colour		52/6
" " " Bright Red		47/6
PRESSED ROOFING TILES, Strawberry colour		33/0
" " " Purple colour		35/0
BLUE VITRIFIED GOODS, of any description		
Stable Paving, Copings, Garden Edging, &c., &c.		
PAVING TILES, Red or Blue		
TERRA-COTTA RIDGES, FINIALS, &c.		

Figure 70 Advert for H. Johnson and Company, manufacturers of Fareham Red Rubbers, c. 1880, (Hampshire Record Office).

Red cutters for carving were sold in two sizes, large at 100.s per 1,000 and small at 80.s per 1,000; and it is indicated that these were used for that purpose at South Kensington Museum, among other notable places.

The emphasis on two sizes is of interest as it is during these years that many rubbers began to be produced to larger sizes than standard bricks. This was almost certainly a direct response to the prolific use of carved enrichments, ensuring adequate 'tailing-in' of projecting elements to the background masonry and reducing unnecessary joints. It was also a response to the move towards the use of the bow-saw to cut and shape the rubbers within profiled cutting boxes, as described in section.2.5.3.

Praise of the Fareham Reds for their consistent and inherent qualities was widespread during these late Victorian years, especially in the architectural and building press. *The Builder* of 2nd September 1871 reported that gauged Fareham reds were being first rubbed smooth on a revolving table (1871, 689). Clearly this was a builder's development to speed up the traditional process of preparation. It then relates how these rubbers were set closely in 'fine stuff' on South Kensington Imperial College, (now part of the Victoria and Albert Museum). Both the small and large rubbing bricks, for carving, were also used on the original part of the Victoria and Albert Museum.

Towards the close of the century a Mr Asher Barfield took ownership of the company. Fareham Reds gradually began to fall from favour, *The Building News* of 27th December 1895 commenting they 'were expensive in the labour of cutting' (1895, 918). This was towards the end of a prolific period in the use of gauged work, however, and competition from other companies producing quality rubbers was peaking.

Kimber's Rubbers

An advertisement in, *The Architect, Engineer's and Building Trades' Directory* of 1868, states (1868, 239):

Thomas Kimber, Ramsdell near Basingstoke, Hants. Celebrated for upwards of a century for roofing tiles, paving ware, clinker and rubbing bricks, etc'.

Midhurst Rubbers

In 1887 the Midhurst, Sussex brickmakers, Tallant Brothers (Figure 71) advertises, 'rubbing bricks equal to Fareham ware' (Beswick, 2001), from their Pitsham and Henley brickyards. Rubbers are still being produced at Pitsham today, but the clay is brought in from further afield.

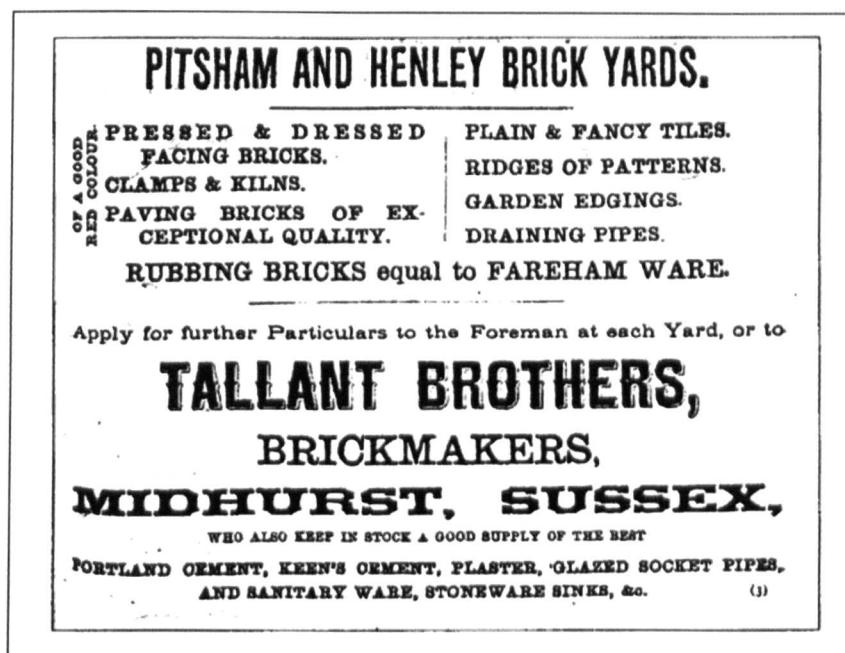


Figure 71 Advert from Brickmaking in Sussex, for Sussex brickmakers Tallant Brothers 'rubbing bricks equal to Fareham ware' from their Pitsham and Henley yards, 1887.

Roshers Rubbers

An advert appeared for F and G. Rosher, Lime, Cement, Brick, Tile and Slate Merchants in *The Architect* of 3rd July 1869, where one might obtain from their London wharfs White, Black and Red Rubbers (1869, x). *The Builder* of 23rd December 1893, however, describes them as (1893, xxii):

Roshers Brick, Tile and Pottery Company. Works: Henley Road, Ipswich, Are the only Makers of the Highly-Esteemed R R Red Rubbers.

The Architect of 3rd July 1869 carried an advert for (1869, x):

Rosher, Lime, Cement, Brick, Tile and Slate Merchants, where one can obtain from their London Wharfs, White, Black and Red Rubbers.

TLB Red Rubbers

The TLB rubber was produced by Thomas Lawrence and Sons of Bracknell (Berkshire), hence the initials that were always stamped on to the beds or frogs of all their bricks. They were considered second only to the Fareham Red, as Walker (1885, 1761) states:

Next in quality come the Berkshire Builders and T.L.B. Rubbers, Made by T. Lawrance [sic] Bracknell, Berks.

No. ones T.L.B.s are good bricks, though less firm than Farehams, but of an even texture; they are divided by colour into two classes - Cherry-red and orange tint. The orange is generally used, as they contrast well with the red building bricks, but will not carry so sharp an arris or weather so well as the darker bricks.

As can be seen in their trade price list of 1898 there were three different types of TLB rubber. In ascending order of quality these were the 'Orange Red', 'Cherry Red' and 'Rich Dark Red', sized at $9\frac{3}{4}$ ins x $4\frac{5}{8}$ ins x $3\frac{1}{8}$ ins (247 x 118 x 80 mm) (Figure 72). Of interest, their prices are not quite double those of their handmade facings. The larger-sized rubbers were significantly more expensive, being specially prepared for carving.

WHOLESALE TRADE PRICE LIST OF FACING & RUBBER BRICKS									
Loaded into Railway Trucks									
At BRACKNELL STATION, S.W.R.									
The Bricks marked * can also be loaded at Wokingham Station, S.E.R.									
No.	1	Selected	Orange Red	Facings, Hand-made, at	d.	s.	d.	per 1000.	
"	2	"	Cherry Red	"	"	"	2	9	6
"	3	"	Rich Dark Red	"	"	"	2	12	0
"	4	"	Orange Red Hand-made	Pressed					
"	5	"	Facings	"	"	"	2	19	6
"	6	"	Cherry Red ditto	"	"	"	3	2	6
"	7	"	Rich Dark Red ditto	"	"	"	3	5	0
"	8	"	Orange Red Rubbers	$9\frac{1}{2} \times 4\frac{5}{8} \times 3\frac{1}{8}$	"	"	4	7	6
"	9	"	Cherry Red	"	"	"	4	7	6
"	10	"	Rich dark Red	"	"	"	4	7	6
"	12	"	Orange Red Facings, Hand-made	"	"	"	2	6	6
"	12 x	"	Cherry Red	"	"	"	2	8	6
"	12 xx	"	Rich Dark Red	"	"	"	2	11	6
"	13	"	Orange Red Facings, Machine-made	"	"	"	2	0	0
"	13 x	"	Cherry ditto	"	"	"	2	0	0
"	13 xx	"	Rich Dark Red ditto	"	"	"	2	0	0
"	16	"	Grey Headers and Stretchers of an unusually bright colour	"	"	"	2	10	0
"	17	"	Machine or Hand-made Paving Bricks	"	"	"	2	10	0
Seconds suitable for inside walls and other rough work at Market Price.									
APPROXIMATE WEIGHTS OF ABOVE BRICKS: - Hand-made Bricks, 83 cwts. per 1000; Machine-made ditto, 61 cwts. per 1000; Rubbers, 50 cwts. per 1000.									
LARGE RUBBERS, $12\frac{1}{2} \times 4\frac{1}{2} \times 3\frac{1}{2}$ at 14/6 per 100. Weight, 11 cwt.									
"	"	"	$14\frac{1}{2} \times 4\frac{1}{2} \times 3\frac{1}{2}$	"	"	"	19/6	"	13
"	"	"	$12\frac{1}{2} \times 7\frac{1}{2} \times 3\frac{1}{2}$	"	"	"	28/6	"	17
"	"	"	$9\frac{1}{2} \times 9\frac{1}{2} \times 3\frac{1}{2}$	"	"	"	27/6	"	15
NOTE.—Instructions are given Railway Co. to cover all trucks containing Rubbers with Tarpaulins, for which they make an extra charge of 1/- per truck.									
ALL BREAKAGES IN TRANSIT AT PURCHASER'S RISK.									

Figure 72 Wholesale trade price list of Messrs Thomas Lawrence of Bracknell, Berkshire, 1898, with types, sizes, and prices of their rubbers, (Berkshire Record Office).

Experience gained in working with original TLB rubbers substantiates Walker's viewpoint regarding the vulnerability of some of their arrises. This is due to the open, almost aerated, texture of the bricks, particularly the orange rubber. One had to exercise great caution with the latter in handling them to prevent losing a prepared arris.

According to Dumbleton (1990, 7):

The firm claimed to have made bricks since 1860, and in 1886 gained the only gold medal for bricks at the Architectural and Building Trades Exhibition. Their circular of 1893 shows that by then they had works at Swinley, Easthampstead, Warfield and Pinewood making 12 million bricks a year.

TLB rubbers were made at two of several brickyards Lawrence operated on the geological junction between the Bagshot sand-seam and London clay. The main yard was the Warfield Brickworks, the second - only in production to meet demand between 1891-1910 - was at their Pinewood works.

Dumbleton (1990, 14) describes how the rubbers were made at Warfield:

Rubber bricks. Special clay from Swinley was mixed with water in a wash mill, a cylindrical tank with radial rotating rakes. The slurry, free from any stones, then flowed down a wooden sluice, through screens to remove roots and other debris, and into the settling ponds called rubber bays. After some months the clay was dry enough for use. The rubber bricks were made like ordinary bricks, in steel-lined 9, 12 or 14 inch moulds, but had no frogs and were stamped T.L.B. with a hand stamp.

In 1988 Walter Spencer, then 93 years old, wrote a personal account for the British Brick Society of his father's long years working at the Swinley yard for Thomas Lawrence Spencer (Spencer, 1988, 20-22):

(Jan 1) ...I thought that you might be interested in some facts relating to the old brickyard owned by Thomas Lawrence....

T L B bricks were framed in their day, and the "Rubbers", a slightly bigger and better quality brick, were used to build the forts outside Portsmouth Harbour....

...Another brick yard was opened about half a mile from the old yard, on discovering that more "Clay Bays" had been found with clay of a much more refined quality. The yard was called 'Klondyke' and the celebrated TLB RUBBER was produced here. These were slightly larger bricks and were more smoothed faced.

...The site of the Brick Yard is now entirely obliterated and except for the undulations of the "clay bays" cannot be traced. It was situated on the left of the Ascot to Bagshot road just before the gradient to Tower Hill commences and covered over a square mile of land....

In respect to the manufacture of TLBs nothing would be added to the clay before moulding, except a handful of soft sand thrown over the rubbers after they were made, and prior to being put in the drying sheds. After the normal drying period they would be placed in coal-fired downdraught kilns.

With regard to the numbers of rubbers placed amongst the standard bricks in the two kilns for firing, the following ratio was given as ...'20,000 ordinary bricks and 12,000 rubbers and the other 30,000 ordinary bricks and 15,000 rubbers...' (Dumbleton, 1990, 14):

The rubbers would be placed in a certain position and level within the kiln to protect them from the main heat behind the standard facing bricks. The rubbers were fired at a temperature of 900°C (about the heat at which vitrification starts to occur), for approximately five days, although this would be dependent on outside weather conditions. After the firing the kiln would be opened and the bricks left inside until cool enough to handle. The cooling period varied and was dependent upon the weather conditions and the position of the kiln. The bricks would then be graded upon being drawn; the expected percentage loss was 4 per cent on average and the shrinkage about 2 per cent.

Wheeler's Rubbers

Wheeler Brothers, formerly Wheeler and Sons, of Coley Kiln in Reading (Berkshire) were brick and tile makers. They produced fine orange red rubbers that have been identified as being those used for the gauged enrichments of the arches and quoins of St Pancras Chambers (London) (1886-8) (Shelton, 2004). It is possible that they also supplied similar bricks for the same purpose for use on the East Side buildings and elsewhere at St Pancras.

Woolpit Rubbers

There were numerous small rural brickyards across Suffolk, such as The Woolpit Brick and Tile Company. *The Builder* on 14th April, 1883 (1883, 498) says:

...of Woolpit, Suffolk, and Moorgate Street, some very good dark and light red facing bricks, red and white rubbers, hard red facings and red moulded bricks. They will all bear inspection.

The Builder of 5th September (1879, 24), stated:

Suffolk white bricks contain a large proportion of sand, hence their suitability for rubbers.

Gwilt (1888, 526) records:

The Suffolk bricks, called white Suffolk's or 'Clippers', are of two or more qualities, expressly made for facings, and are expensive; the best are rarely obtained in London, being sold in the locality of their manufacture... The works supply superior white and red (kilnburnt) Suffolk facings, splays, door-jambs, coping bricks, stable clinkers, &c dark red facings, rubbers, splays, paving bricks, &c; bright yellow malm facings and cutters of best quality.

2.5.2 The Introduction of Scientific Testing

By the end of the nineteenth century, improved methods of brick making and the rapidly changing technology of brick construction meant that architects and engineers demanded information on how masonry, including individual materials, would perform by quantitative testing. Rubbing bricks were no exception. *Rivington's Notes on Building Construction* (Rivington, 1901, 112) gives the defining characteristics of good rubbers:

A really first-class rubber will not be easily scored by a knife even in the centre, and the finger will make no impression upon it... Such a brick will be of uniform texture, compact, regular in colour and size, free from flaws of any description.

Rivington also recorded 'the sizes and weights of the best-known varieties of British bricks'. This included the Fareham Red rubber, the dimensions of which are given as, 10.9 ins x 4.8 ins x 2.9 ins, and its weight recorded as 8.8 lbs. This is as opposed to the standard Fareham Red facing brick with dimensions of 8.5 ins x 4.15 ins x 2.6 ins and a weight of 6.3 lbs (Rivington, 1901, 113). One can determine from this that the Fareham Red rubber was oversized, particularly in its length, but less dense than its facing brick counterpart (0.058 lbs/in³ compared with 0.069 lbs/in³).

Since water is one of the main decay agents in brick, knowledge of the presence and movement of water within a brick is very important. Rivington recorded information on water absorption by different varieties of brick, including a malm cutter, which was shown to have the highest absorption recorded, at 22% (Rivington, 1901, 114).

Rivington also considered the comparable compressive strength of rubbing bricks with other bricks. The results of testing showed that the rubbing brick was weaker than the other bricks tested, failing at four tons (Rivington, 1901, 115), which was significantly lower than the other types of brick tested. This was further substantiated in the results from similar tests on the crushing strengths of various types of brick, undertaken a few years later (Mitchell and Mitchell, 1904, 327-8).

The low crushing strength demonstrated by rubbing bricks is due to a combination of factors - their fine washed structure, low-fired temperature, and characteristic large voids volume, typically around 35%, which defines their porous nature. Yet it would be wrong to categorise these soft bricks as being constructionally weak and non-durable in the context they were used. Historical use has proved that cut and rubbed and gauged brickwork, properly detailed, will last as long as standard facework. This is due, in part, to the soft lime mortar that was used with these bricks. structural engineer Lachlan McDonald writes:

In Victorian brickwork red rubbers were commonly used to form arches with panels of brickwork over. The construction involved the use of lime mixed with fine sand to reduce shrinkage and the joint width restricted to around 2-3 mm maximum for gauged arches, and as fine as 1 mm, depending on the available budget and skill of the craftsman; and up to 6 mm in ashlar work. Despite the low compressive strength of the mortar and the brickwork, it is a general view that if constructed with thin joints this brickwork performed well; even if it was significantly overstressed by modern standards.

The soft lime mortar can distribute the forces within the brickwork over several courses, with much more efficiency than a modern hard cement mortar (McDonald, 2002). Additionally, due to the plastic nature of the mortar, small movements can be accommodated in the joints without cracking the bricks, and cracks within the lime mortar itself, following movement, are often re-sealed due to the so-called 'autogeneous healing'. Although this mechanism is not well understood, it is likely to involve continuous carbonation, or re-carbonation, of deposits of lime out of solution. Furthermore, the porous nature of both the bricks and the mortar is more favourable to water movement, allowing wetting and drying-out to occur, leading to less trapped moisture than occurs with cement construction. This improves the weathering characteristics of the brickwork.

The hardness (compressive strength) and water absorptivity of bricks are two properties often linked to their frost resistance. In this respect, one might expect harder bricks with low water absorptivity to show a greater frost resistance. However, these properties have never produced a dependable indication of frost resistance (Hammett, 2004). There are many examples of bricks with only modest strength (7-20 N/mm²) and high water absorptivity (20%-30%) that, nevertheless, have excellent resistance to damage by frost action. It is believed that one of the main contributing factors to the resistance, and hence durability, of cutters and rubbers is their extensive pore structure, which makes them very efficient at transporting moisture (Pavia and Lynch, 2003, 19).

2.5.3 Victorian and Edwardian Bricklayers

The high level of building activity during the mid-eighteenth century had seen the complete disappearance of the guilds, and a rapid decline in the time-honoured hierarchy of master, journeyman, and apprentice. By the beginning of the Victorian period, master bricklayers were relatively rare in London. Big businesses sprang up regulating wages and conditions of work, changing building from a craft-oriented industry to one of general contracting, a contractor estimating for a whole job. This had early consequences in quality of craftsmanship for the embittered workers who had now lost control of their work, prices and traditions.

Despite hostility, the time-served craftsmen worked on the prestigious contracts or on the parts of a building requiring knowledge, experience and skill, but the rest of the trade was being flooded with cheap semi-skilled labour, content with lower rates than the craftsman bricklayer. The Statute of Apprentices (1563) was not being enforced, as it was seen by government and employers as outdated and not suited to the new market place. The prevailing spirit of 'laissez-faire' meant that the building industry was not investing in its future, with provision for apprenticeships, and although a seven-year apprenticeship was theoretically operational, it could in reality be as short as four or five years.

This concern was picked up by a correspondent in *The Builder* of 18th December 1847 (597):

On more than one occasion we have mourned over the decay of skill amongst our operative bricklayers.... Bricklayers are no longer animated by the right spirit; pride in their work they have none; anxiety to excel exists no longer.

...The men themselves are scarcely to blame: they have not had fair play. There are few apparent inducements for good work or superior skill; rapidity and bad work are what their masters have desired, and the result is, that men capable of executing good work are with difficulty to be found...

The Tylers and Bricklayers Company managed to recoup many of the financial losses of the eighteenth century, and this money was used wisely to keep a close alliance with the craft it represented. Although its powers of search and craft supervision had long since lapsed, it concentrated much of its effort in supporting the building trade training schools. From the 1870s, to ensure a future supply of much-needed bricklayers skilled in the craft, the company gave a £25 premium to master bricklayers willing to take

apprentices (Bell, 1938, 57). This sponsorship succeeded in salvaging many skills, badly needed for the next century that might otherwise have been lost.

In 1878 the City and Guilds of London Institute was established by the Corporation of the City of London (the 'City') and certain of the London Livery Companies (the 'Guilds') for the advancement of technical education. In the 1890s, by examinations of apprentice and journeymen, it was hoped to bring skilled recruits to bricklaying. The Tylers and Bricklayers Company, in a substantial grant to the City and Guilds, helped to support the project by giving £20 towards medals and prizes to encourage industrious study.

Despite these efforts to raise craft standards and pride, there remained much concern about the true benefits to the bricklayer on site. This was particularly true for those needing to be highly skilled and educated in order to set out and produce the quality gauged work then being designed, yet have the craft protection the guilds once offered.

The emergence of newly legalised trade unions in the 1870s meant that overall conditions began improving for building craftsmen and some sense of craft pride returned. The Operative Society of Bricklayers was formed in Manchester in the early 1800s (Postgate, 1986), their aim being to align themselves to the best qualities of the old guilds, rooted in traditional crafting skills, sound technical knowledge, and pride.

In 1863 the Society commissioned the Royal Academy artist A.J. Waudby to design a membership certificate (Bellamy, 1986). Study of this most attractive certificate allows one to see how the members wished to see their craft displayed and how an emphasis was placed on gauged work. It portrayed scenes of a 'cutter' at work in the cutting-shed and a bricklayer setting an arch (Figure 73).

That gauged brickwork was considered the supreme test of mastery within the craft is confirmed by Noble (1836, 28):

At a former period, it used to be the pride of the bricklayer to produce a specimen of his skill, in the formation of a Roman Doric column and entablature, or some other elaborate form, in gauged brickwork: but it subsequently ceased to meet the eye of the architect, and gave place to rapid, coarse, and too often imperfect execution; result of new system of operative task work.

Demand for quality handcrafted brickwork, begun in the period of the Gothic Revival, was explored to new and exciting creative possibilities by the so-called Queen Anne Style, leading to a renaissance of the use of gauged brickwork. This was especially so in wealthy, vibrant, and hugely influential London.

Master bricklayers possessing skills and knowledge of gauged work provided the main route for the chosen apprentices to learn from. By the third quarter of the nineteenth century it was also possible for indentured apprentices to attend new technical colleges under the auspices of the Board of Education in London (Rivington, 1901, VII) and later the City and Guilds of London Institute, to be taught the craft. In this environment the more able student could gain the theory, technology, and practical tuition to supplement site work, enabling him to produce gauged work to the most exacting of standards.

The duration of apprenticeships was generally accepted as four or five years (but could still be seven, much depending on one's experience prior to indenturing), a fee being paid by the boy's parents, or guardians, to the master or, more commonly, the company to whom he was 'bound'.

Qualified lecturers were chosen for their craft skills, technical competence, wide experience, and ability to convey their subject in an erudite manner. Most were site men (some from the army's engineering corps), formerly employed as foremen bricklayers, general foremen, or clerks of work. Attracted to teaching by that love of the craft, lecturing now offered better conditions of service and workplace, status, and well-motivated and disciplined students; all characteristic of the prevailing social attitudes of late Victorian England.

An assessment of what was being taught to apprentice bricklayers about gauged work in the technical colleges of the late Victorian period, can be gleaned from the syllabus and examination questions of *The City and Guilds, Subject 57, Brickwork*. The following questions are taken from the Ordinary Grade (as opposed to the advanced Honours Grade) from 1897 to 1899 (Richards, 1901, 126-31):

- 1897 Arches – Names of the different kinds and mode of construction. Bond in arches, and description of their various parts, such as soffit, skewback etc
- 1897 Draw to a scale of 1" [inch] to 1' [foot] the elevation of a camber or straight arch, 14" [inches] on the face and 9" [inches] soffit, for a 3' [foot] opening.
- 1897 Brick – cutting (A) Setting out work in detail from architectural drawings, and obtaining the templets, moulds etc., e.g. arches moulded and plain, cornices, caps pediments, pilasters, aprons, and gauged work generally. (B) Cutting and finishing any required piece of gauged work from templets and moulds supplied.
- 1898 Draw to a scale of $\frac{1}{8}$ [one eighth] half the elevation of a moulded segment arch for a 3' [foot] opening. The moulding to be 2 $\frac{1}{4}$ " [inches], the face of arch 12" [inches], the rise 3" [inches], and the soffit 4 $\frac{1}{2}$ " [inches]. Also show four top courses of the reveal and skewback in Flemish bond.
- 1898 Annexed (Fig. 218) is the plan of a 1 $\frac{1}{2}$ brick wall in English bond, with a Gauged pilaster projecting from it. Draw the alternate courses to a scale of $\frac{1}{8}$ [One eighth]
- 1899 Draw to a 1" [inch] scale the elevation of an equilateral or Gothic arch, 12" [Inches] on face, for a 3' [foot] opening, showing in the arch two ways of filling in [tympanum].
- 1899 To a scale of $\frac{3}{4}$ " [three quarters of an inch] to 1' [foot] draw the elevation of a plain [un-moulded] segmental arch, 14" [inches] on the face, for a 2' [foot] opening. The rise to be 12" [inches].

Finally, from *The City and Guilds, Subject 57 – Brickwork 'Honours Grade'* (Richards, 1901, 132):

1900 To a 1-in [inch] scale and for a 3-ft. 6in. opening, draw the elevation of a gauged arch 14 ins. [inches] on the face, with a projecting and moulded key. The arch is to have a 15 -in. [inch] rise, but to spring from a level bed similar to a semi, and the soffit and reveals are to have a 2¼-in [inch] moulding.

To support lecturers and apprentices there were several books on brickwork featuring small sections, or chapters, on 'gauge work', as it was being referred to through to the 1880s, such as Hammond (1875 and 1879) and Walker (1885). Many were written by lecturers intending them to also be of assistance to site bricklayers.

In the shires, traditional craft apprenticeships continued to be highly prized and viewed as the best possible avenue to learning, though there were no colleges to support this. H. W. Masons, General Builders, Undertakers and Monumental Masons, of Newport Pagnell (Buckinghamshire) have retained their Silver Street premises since 1764. The master bricklayer, Henry William Mason (1873-1952), grandfather of the present owner Mr Roy Mason, followed a long-established custom of being apprenticed at 14-years old to a master at another family company. In this instance, it was the highly respected firm Marriots of Rushden (Northamptonshire), who worked not only locally but also in the capital. At Marriots, he was introduced to the cutting-shed and gauged work. Upon qualifying as a journeyman in 1893, he was put to work in London to gain additional knowledge and experience of high-level craft skills such as gauged work. This enhanced the quality of building work that Henry Masons and Sons could then offer their clients once he eventually returned to the family business. Amongst the city craftsmen he was recognised as a very knowledgeable and talented bricklayer and on 21st October 1893, he was admitted to the Operative Bricklayers Society's (OBS) Harrow Road branch. His membership certificate, number 21382, survives today in the ownership of his grandson (Mason, 2003).

2.5.4 Changes in the Cutting-Shed

Early Victorian cutting-sheds were still erected on site, but as these became more congested, particularly in the city, they were increasingly kept in the builders' own yards. The finished cutter's work would be dry-assembled in numbered order and

carefully packed into protected casing for delivery for on-site assembly. When the fashion for enriched gauged work returned in the second half of the nineteenth century many craftsmen remained solely in the workshop to cope with this demand so becoming experts at producing all forms of enrichments. In the small towns and rural areas, however, the bricklayer would continue to set his own cut work. The tools and techniques of the cutter (the term 'hewer' by then being rarely used) were still those of the Georgian period.

The tools and implements used for making gauged arches, only a decade before the accession of Queen Victoria in 1837, are detailed by Pasley (1826, 240-41) as:

1. A banker or bench, on which the bricklayers prepare their bricks.
2. A camberslip or ruler, curved in the proportion of about 1 inch in 6 feet. This marks the moderate curvature usually given to the intrados of flat arches over doors and windows...
3. A large board, for which an old door is frequently used.
4. A lath is used for describing semicircular or segment arches, with a nail driven through one end for the centre, and a pencil at the other end of it.
- 5th. The instrument called a trammel for describing elliptical arches.
- 6th. A mould. A piece of wood 15 or 16 inches long, cut on each side to correspond with the radiating joints of the proposed arch...
- 7th. A pair of steel compasses.
- 8th. Rules, such as by carpenters are termed straight edges.
- 9th. A small square with a brass blade.
- 10th. A small level with a brass blade for marking bricks that are to be cut obliquely, which is also necessary for the joints of groined arches...
- 11th. Templets, which are rectangular pieces for the purpose of marking the lengths of the several arched bricks. A long templet is used for marking those bricks which appear as stretchers; and a shorter one for marking those which appear as headers, in the face of the arch.
- 12th. A small tin saw with a wooden back and handle, ...to commence the cutting of a brick, in order to prevent it from splintering.
- 13th. A brick axe to complete the cutting begun by the saw. It has an edge at each end, like a very large chisel, with a round stem in the centre for grasping it. It is used by striking down over:
- 14th. A chopping block.
- 15th. A rub stone, to give the bricks a smooth surface, after being axed. This is a thin round stone fixed on the banker.
- 16th. A float stone. This is a stone convex on one end, to rub bricks to a concave form when necessary, as in niches, &c.

In so many respects these tools had changed little from the time of Moxon, Neve and later Nicholson. It is likely that the slow pace of development in gauged work was not just conservative practice in the cutting-shed, but due to its fall from fashion in the late eighteenth and early nineteenth century as Pasley (1826, 221-2) indicates:

Formerly it was customary to have ornamental fronts of brickwork, which were prepared by cutting and rubbing the bricks, and when it was the fashion to build with red bricks, the

ornamental parts were usually of a deeper red than the rest of the wall, and the bricks selected for this purpose bore a higher price, and were termed red rubbers.

In this manner, brick pilasters, with friezes, &c., were made, and it was also customary to rusticate brick piers, or the coins of buildings.... In the present day, the practice of using brick ornaments of this description is almost obsolete, ...

The brick axe still remained the main cutting tool and studying Pasley's description (point 13) it is evidently the large axe detailed in section 2.4.4. Study of the membership certificate of the Operative Society of Bricklayers for 1863 and the emblem of 1869 by A.J. Waudby (Figures 73 and 74), one sees the brick axe represented several times

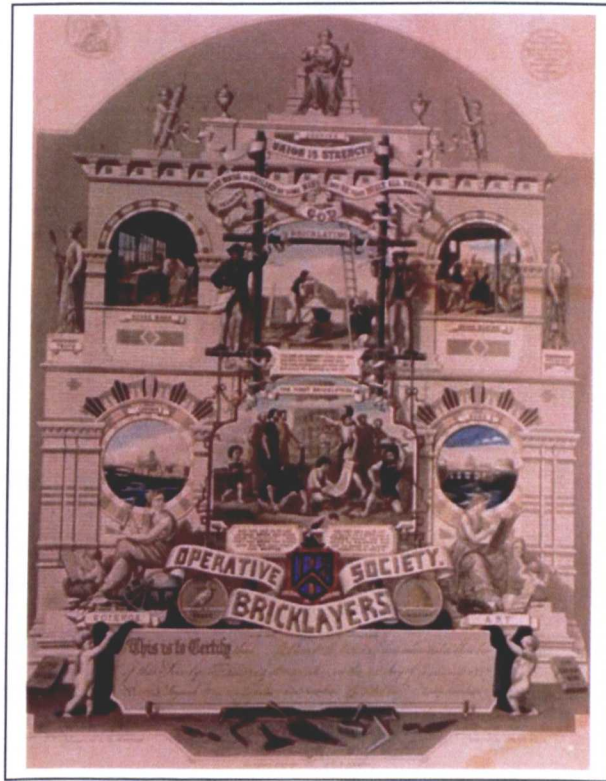


Figure 73 *The Operative Society of Bricklayers membership certificate by A.J. Waudby, 1863.

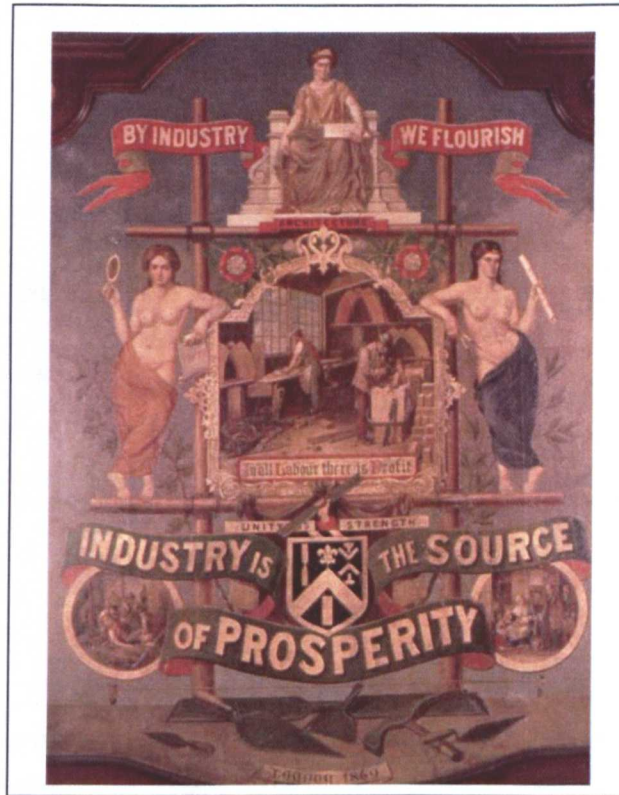


Figure 74 *The Operative Society of Bricklayers Emblem, by A.J. Waudby 1869 (The People's History Museum, Manchester).

In the 1863 certificate it can be seen on the coat of arms held above the shield and amongst a collection of the bricklayer's tools at the bottom. It is to be seen in the depiction of the cutting-shed, incorrectly spelt Guage [gauged] Work, where it leans against the chopping block where the cutter works a brick. In the later 1869 depiction of the cutting shed (Figures 75 and 76) two craftsmen are shown at work cutting Gothic arches, one at the rubbing stone and the other at the chopping block. In all of these pictures one can truly assess the size of the large brick axe in contrast, not only to the other tools, but also to the craftsmen.

During the early nineteenth century toolmakers' catalogues from Sheffield show itemised plates with the brick axe for sale; usually by weight, an important factor in the clean cleaving of bricks (as described above). This demonstrates another of the dramatic changes been felt by the growth in mechanisation, with specialist tool factories replacing individual handcrafted tools forged by the builder's own blacksmiths.

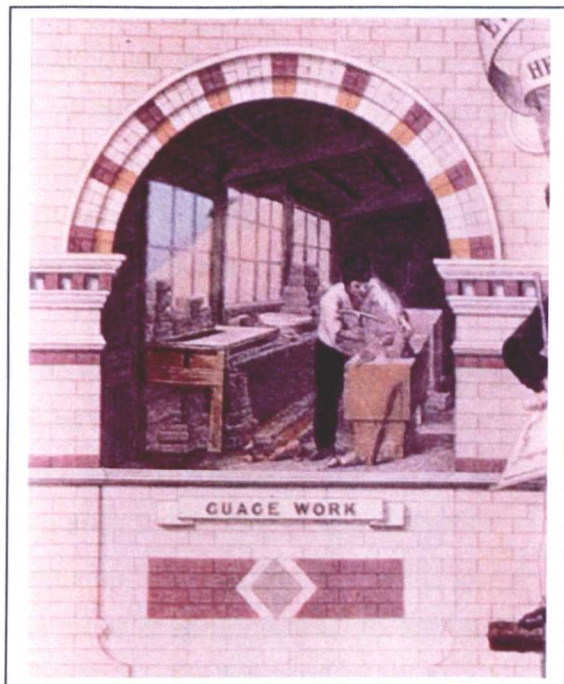


Figure 75 *Large brick axe lies against the chopping block in A.J. Waudby's 1863 depiction of a cutting shed, (The People's History Museum, Manchester).

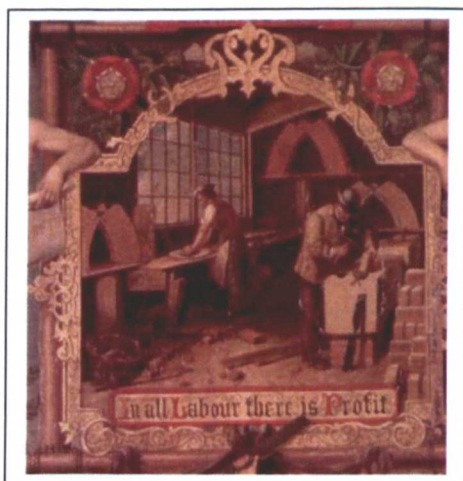


Figure 76 *Depiction of a cutting shed, where two cutters are preparing gauged arches, the large brick axe again lays against the chopping block, by A. J. Waudby 1869, (The People's History Museum, Manchester).

The Waudby depictions of a cutting-shed are of singular interest as they provide a rare glimpse into this normally secretive workplace. Also one can see the then common arrangement of cutting at a chopping block, away from the banker upon which rests the rubbing stone and bedding slate.

The chopping blocks depicted are sturdy - not unlike a butcher's block - unable to move or vibrate. Waste from brick cutting is shown at the cutter's feet, both from the brick axe and the club hammer and bolster. The cutter is using a wooden hafted tool, most likely a form of scotch to chip the brick to shape, as it is securely hand-held in a suitably shaped wooden seating or cutting block.

The cutting block would be made of a hardwood, such as elm, to be robust enough to endure the long-term abuse it would be subject to. In design it could be an arrangement of two blocks, screwed to a base and fixed to support a brick in an angular position. Alternatively, it could be a solid timber block cut to an angle of between 45-60° to the vertical, to create a 90° seating to the incline. Both allowed the brick to rest securely whilst being worked. This piece of equipment facilitated greater precision, as it prevented the brick moving as cutting blows were struck and thus prevented disfiguring chipping and rounding of the all-important sharp arrises. This invariably occurs if bricks move during cutting and shaping due to the abrasive action of the small particles of resultant waste that collect and get under it.

Waudby's certificates and emblem paintings are also important as time capsules, for they show a brick axe in the cutting-shed at a time when it was beginning to fall from popular use. This point is emphasised in the answer to the question from a Mr Clarry, 'What is a Brick-Axe?'

The Builder of 26th June 1880 responded (1880, 808):

Sir, - if 'Clarry' had put that question to a bricklayer thirty years ago he would have smiled at his ignorance. Well, sir, a brick-axe is, or was, an iron tool, like the ends of two crow-bars joined, flat at each end, and round at the centre, for the hand to hold it, with about 4 in. of steel at each end, and its length was about 2ft.6in long, according to fancy or a man's ability to use it. The axe was made to cut gauged brickwork after the bricks had been marked to the mould, as described by John Philips in some of your former numbers, some years back, and excellent letters they are, and well worth a bricklayer's time to read them. The brick-axe is not used now*, as an iron or steel cutter is used to cut the bricks, it being struck with the club-hammer. This gives much less trouble. It required some practice to use the brick-axe with skill, and it was much harder work.

George Brown, Bricklayer.

*We saw it in use not long ago in Islington. — ED.

Any craft tool and the established practice of its use rarely fall completely from use inside 30 years. Older craftsmen tend to stick to familiar tools, equipment, and craft

techniques that have served them well down the years, and resist change. Thus the Editor in his footnote, and Waudby in his drawings, are correct in what they saw.

Certainly by the 1870s Sheffield tool catalogues were neither displaying nor selling brick axes, only advertising small versions for use as 'brick cleaners'. The emphasis had moved to the 'scotch' (or 'scutch') hammer to finely cut, dress and finish the brick true to the desired shape, particularly if it was to be moulded.

The scotch became popular from the mid-nineteenth century probably due to the introduction of steel. It replaced the iron-bladed brick axe, most likely because of increased use of harder machine-pressed bricks. The scutch consisted of three distinct parts: stock, blade and wedge. Often old files were re-worked into blades because of the suitability of the steel. A hardwood wedge secured these. The origin of the term 'Scotch' is obscure, although it is known to be of late medieval origin and means, 'to make an incision, cut, score or gash'. To 'scutch' is to strike, whip or slash.

The scotch (Figure 77) is similar to a 'millers bill' or, more correctly, the 'mille-bille and thrift'.

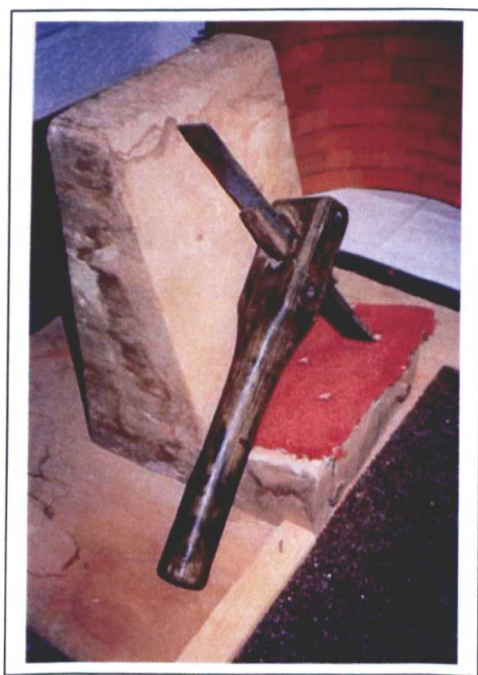


Figure 77 Bricklayer's Scotch.

The mille-bille is an edge tool of high-carbon steel, pointed at each end and wedged into the handle or 'thrift' (being removable like the carpenter's iron in a plane) and held secure by a leather tongue; rather than the timber wedge of the scotch. The bille and

thrill is used for dressing and cutting the furrows in millstones. Richard Filmer and Kenneth Major of the Tool and Trades History Society (TATHS) have stated (2001):

...the brick scutch was also used by mill-dressers for 'stitching'. This is the process of producing grooves – often twelve to sixteen to the inch [25 mm], - rather like a file, on the 'lands' between furrows. Obviously this was a better tool to use for this particularly fine work, and was also presumably rather easier to sharpen than the mill –bill. The metal, of course, was subject to a very severe hardening process.

The stonemason, Piers Conway, has also commented on this fact (2002):

I watched a programme on the restoration of a mill in which a chap was re-cutting the old millstone, (a trade in itself), and he was using a traditional dressing axe called a 'Thrill' with inter-changeable mill-bills and picks. This implement was very similar to your Victorian 'scotch' and may well be the missing link from old stone working traditions from the earlier brick axe.

The influence from stonemasonry once again appears, albeit in an obscure manner, in the bricklayer's cutting shed.

The changes that were taking place in the cutting-shed of the second half of the nineteenth century reflected standards being set for brick enrichments by architects following the Gothic and Queen Anne revival styles, keen to emulate the high levels of past masonry craftsmanship.

Study of contemporary cut brick arches, reveals there were two accepted classifications – 'axed' or 'gauged'. The term 'axed' (from the use of the brick axe), retained even when the scotch and hammer and bolster were substituted, is still used today. Hammond (1875, 24-25) details these two classes, defining 'axed' arches by the standard of the late Victorian period:

These are used very much in the present day, on account of their taking less labour, as it is thought. But it is an inferior sort of work at the best, and often costs as much as gauge-work by the time it is finished.

The bricks of these are simply axed down to a given size, and nothing but the soffits are rubbed; and this is done after they are brought to the required bevel with the hammer booster and scotch; they are then set in cement, with a joint about three-sixteenths of an inch in thickness, and afterwards pointed.

One can determine that, despite being then set with joints of only three-sixteenths of an inch (5 mm) in thickness, it is considered inferior to gauged work. The use of a cement mortar for such work was not uncommon on some of the big city sites, especially from

the 1860s, but it was not remotely approaching the high strength of its modern ordinary Portland cement (OPC) counterpart (Livesey, 2003):

The 'Portland cement' of 1850 was a different animal to that of 1900, which in turn was totally different to that of today.

Hammond's pointed finish for a contemporary axed arch would have been 'tuck pointing'; but always using thinner ribbons than that normal for surrounding standard face work. This was important for creating the illusion of the gauged arch it was intended to replace and imitate.

Hammond (1875, 25-26) defines contemporary gauged work and its preparation as:

... all kinds of work that is cut and brought down to a given gauge upon the rubbing-stone; such as all kinds of arches, mouldings for external cornices, architraves to doorways and windows, eaves, &c., and is considered the most important branch of the trade.

For this purpose a shed should be built to protect the bricks that are to be cut from the wet, and also large enough for the workmen to erect their benches and chopping-blocks to suit their own convenience. They then require the rubbing stone and a bedding-block. The former ought to be in the form of a circle, and not exceeding 14 inches in diameter; for if it is, it will be very likely to rub out of level on the face, that is either hollow or cambering; and even with this size it will be found necessary to turn it round in its bed about once a day when in use, for if the stone is un-level the bricks will assuredly be the same, making very bad work.

The bedding-block is square and of a perfectly smooth surface. It is used for the purpose of scribing and fitting the bricks to the moulds, and is usually made to the size of one course of the arch, if double-faced; if not, about 14 by 18 inches.

This description ties in well with Waudby's depiction of a cutting-shed. The bench (banker) and chopping blocks, which Hammond describes, are shown, as are the rubbing stone and bedding-block (slate) on the banker. The cautionary note to check that the rubbing stone does not rub hollow illustrates the huge volume of work being undertaken at that time.

Regrettably, Hammond does not describe the tools employed for cutting the gauged work. He does, however, provide a valuable clue as to how the bricks were being prepared for gauged mouldings (1875, 42-43):

In many places this is done by simply making a template the form of the brick required, and marking the brick, first on one side and then on the other, and so cutting or rubbing it down to these marks. But for moulding birds' mouths, splay, bulls' noses, and, in fact, almost any kind of work, it will be found much better if a box is made that will hold three or four bricks, either flat or on edge, as they may be required, taking care that the ends are both alike, and the exact shape of the brick required. If this method be properly worked it will be found very accurate, and done with a great deal less labour. The boxes for this purpose are usually

covered with tin or sheet-iron to protect the wood from wearing away while working the bricks; if not, the moulds are very apt to get out of their proper shape and so lead the workman wrong....

In this passage Hammond describes the use of boxes termed 'cutting' or 'moulding' boxes, shaped to profile so that the 'squared' rubbers can be placed in and worked to shape; as opposed to using a single templet. There can be little doubt that shaped moulding boxes had been in use for a very long time in the better cutting-sheds. Through careful study of a photographic enlargement of the original Waudby's depiction of gauged work (Figure 75), a large selection of profiled cutting boxes can be seen on and under the banker, and on the window cill.

Given the tools that Waudby's cutter is employing, the boxes would be only to scribe the desired profiles on the squared bricks. Then, after their removal and axing to size and shape, they would be replaced to position within the box for precise finishing by abrading. Working between the opposing profiled sides, using various large files, rasps, and other abrasives would control this.

Hammond states the edges of the box are covered with tin, or sheet-iron, to stop wear while working the bricks, thus preventing distortion of the finished bricks. Practice proves that it is not possible to use a brick axe or scotch to cut rubbers to shape in a cutting box, as the arrangement does not facilitate this. The two profiled ends are unable to control the cutting tools, essential with the cutting-box method, and the debris created quickly clogs the box.

In order to use the cutting or moulding box correctly demands a tool that can be used across the width of the box along the opposing profiles, reducing the rubbers to perfect size and shape in one pass. The answer is provided in a description of the practicalities of cutting gauged-work by Walker (1885, 83-84):

[Figure 78] ... shows the kind of box that is used for cutting moulded bricks to any required section – in this case an ogee. The box is generally made to hold two headers or one stretcher. The brick or bricks, having been squared and rubbed down to the required thickness, are placed in this box and with the bow-saw roughly cut out, and then rubbed down to the section of the box with a rasp, and sometimes a piece of straight gas-pipe to form the hollow members, the bricks being very soft. ... The cross piece or pieces on the top of the box are omitted for the sake of clearness.

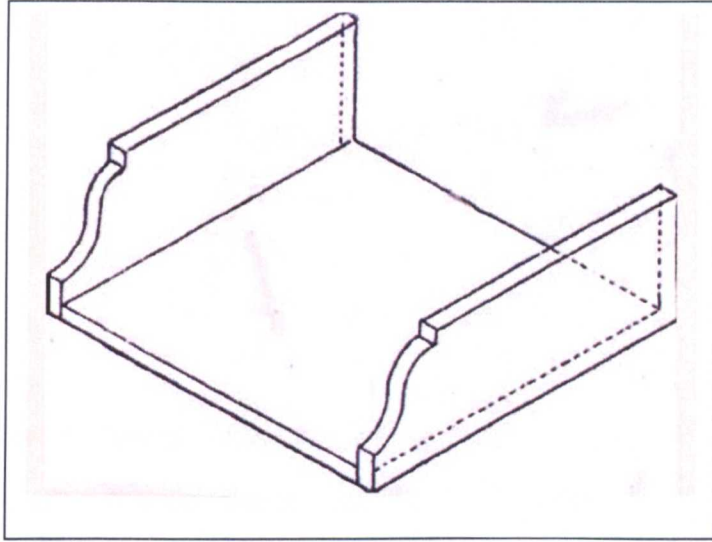


Figure 78 Timber cutting box for an Ogee moulding.

Walker's terminology indicates the bow saw was, by then, a familiar tool in the cutting shed. The 'cross piece' generally termed the 'bridge', spreads the pressure of the vertical strut clamping the rubbers within the box, wedged between it and an overhead beam above the bench. The bow-saw technique made cutting easier, increasing accuracy and facilitated precise finishing. It also largely removed the need for reverse templets to check and finish; except for internal curved mouldings and stopped returns that cannot be cut in a box, but only by the older techniques of hand-cutting and abrading.

Hammond, in his above description, simply assumes the reader knows the wire-bladed bow saw is the tool used for cutting, and indeed later he states (1889, 21):

It is the practice now to do everything possible in a good red brick cutting with the bow-saw...

He also discusses the dramatic effect of the bow saw within the cutting shed:

There is nothing connected with cutting that has caused a greater revolution during the last few years than the bow-saw. Whether for boxing mouldings of any description, reducing bricks for ashlar or arches, cutting scrolls, and every kind of work, the bow-saw is the most convenient invention. In fact the cost of labour connected with gauged work has been reduced vastly by its use, and a short description may be found useful here for those who have not been in the habit of using it.... The upright sides should be about 16in. long, and $1\frac{1}{2}$ by $\frac{7}{8}$ in. in section, and the crosspiece a, [Figure. 79], about 2 feet in length, the same thickness as the upright sides. This is morticed loosely into the latter, and held in its place by means of a screw, but not tightly. This completes the woodwork....

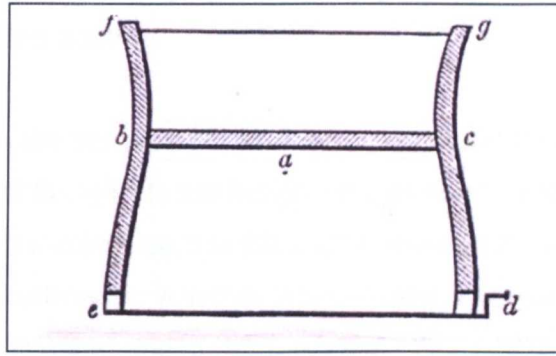


Figure 79 Drawing of a bow saw with a winch to twist the wire blade.

Hammond (1875, 43) mentions three or four bricks being placed in the box for cutting, which is revealing. The rubbing bricks would have to be soft and easily cut, otherwise one cannot cut that many in a cutting box together with the bow-saw. When cutting along a box, the blade naturally rides up higher inside the brick the further it is away from the controlling sides of the box where the cutters hand pressure is at its strongest. Indeed with modern, harder, rubbers one is limited to a box holding only two bricks, and sometimes only one. To overcome this the cutter is forced to ease off the pressure occasionally, allowing the blade into the central section of the bricks to catch up with the sides. This was not so common with the older types of traditional rubbers, such as the original TLBs, which cut more easily and quickly.

The blade for cutting rubbers in a cutting box was steel wire, looped and twisted so its entire surface area became plaited, and thus serrated, providing a 360° cutting edge. This was a development of the small bow with a single wire used for cutting away surplus clay off the top of the box by some brickmakers during moulding. Wire, until the invention of the mass extrusion process during the American Civil War (1861-5) was only available in small lengths, cut as strips from thin sheet metal. This would not facilitate the lengths required on a daily basis for a busy cutting shed, which is why we only begin to read of the wire-bladed bow saw method after this time.

Making a Twisted Wire Blade

The method of twisting wires varied, as would the wire diameter, 16-18 gauge being favoured by the author, as a thinner wire gives a finer cut. Some craftsmen cut two separate lengths of wire (typically the length of the bow saw plus about 150 mm) and tie them off at either end. Alternatively (and more commonly) one simply loops a similar

double length of wire and then, bringing the ends together, tie them. The wire is now ready to be twisted to form a blade.

To twist the wire to form the serrated blade, there were again several methods. The first involves tying one end of the wire to the handle of a galvanised pail and hooking the looped end over a nail in a crossbeam in the cutting-shed roof. One then spins the pail until the wire is twisted sufficiently. Another method uses a carpenter's brace into which a hook is located to receive one end of the wire. The other end of the wire is looped around a bent nail, or hook, fixed to a vertical post and the brace wound until the wire has the number of serration's required per length of wire; the more, the greater the cutting effect. This twisting technique would not have been unknown, as it was a country practice was used to make hay ropes.

Whichever method is employed one must always conclude by turning the brace back several revolutions to release the tension created in the wire otherwise the blade will spring dangerously upon being released.

Hammond (1889, 91-93) provides variations on making blades and types of bow-saws used:

...Some prefer to have the wire twisted before it is fixed to the frame; others to fix it in the frame and twist it there.

If the latter way is adopted there must be a small winch attached to the bottom of the frame at *d*., and a small shaft running through the latter, with a hook to receive the wire. This wire is then fastened to a nail or screw at *e*, brought under that end, and fastened to the hook of the shaft running through the end *d*. Then if a plain piece of $\frac{3}{16}$ wire is made to run through the top *f g*, and fastened with a nut or thumbscrew, the winch can be turned and the wire twisted and tightened at pleasure.

If the wire is twisted before it is fixed in the frame, the tightening is done by a piece of strong string and windlass (such as carpenters tighten their bow-saws with), or by means of two small rods of iron, each running half-way across from *f* to *g*, with a thread worked on them in the centre where they meet and so loosened or tightened by means of a "union;" and this method, if properly constructed, is not to be despised...

Lloyd, (1925, 73) also states:

Recently the hack-saw.... has superseded the tin saw for making incisions, and has displaced the scutch for some brick-cutting. It is also used for cutting soft bricks.

Although a hacksaw could substitute a 'grub saw' it is no match for the wire blade because it keeps its direction better when cutting through the brick than a blade, which tends to twist during the sawing action and therefore does not give such a precise cut. A hack-saw blade is limited in use to only straight cuttings, lacking flexibility to follow intricate mouldings.

The last quarter of the Victorian period saw all the basic essentials of improved rubbers, layout of cutting-shed, and alternative craft tools and techniques for producing gauged work firmly established. For these reasons many modern commentators mistakenly cite the bow-saw method as the way to execute gauged work, based on contemporary craft books. This including the description of gauged work by Richards (1901, 45-46):

GAUGED work consists in rubbing and cutting to any required shape specially made bricks, or "rubbers," as they are technically termed. This class of work is usually done in what is called a cutting shed, provided with a bench about 2'3" [675 mm] high and 2'6" [750 mm] wide.

The tools and appliances required are a rubbing stone (Park Spring, for preference), circular in shape, and 14" [353 mm] diameter; a bow saw fitted with twisted annealed wire No. 18 gauge, parallel file 16" [454 mm] long, small tin scribing saw, square, bevel, straight pieces of gas barrel for hollows in mouldings, etc. bedding slate to try the work for accuracy, straight-edges, compass, setting trowel, putty box, booster club hammer, and scotch (the three latter for axed work), reducing boxes for thickness and for length, moulding boxes, boxes with radial sides for obtaining the wedge-shape voussoir according to the template ...

Long gone from this description is any reference to the use of the brick axe and a separate chopping block. Richards (1901, 49) describes in his contemporary definition of 'axed work':

Axed Arches – Axed arches are really roughly cut gauged arches with a $\frac{3}{16}$ " mortar, instead of a $\frac{1}{32}$ " [0.8 mm] putty joint. Therefore the mode of obtaining the template and the system adopted for gauged arches generally, applies equally well to axed ones: the only difference being that when the bricks are hard, the brick will have to be scribed each side to the template and across the soffit with a tin scribing saw, and cut off to the scribed lines with a booster (sometimes called bolster) and club hammer upon the banker, and the remaining material between the scribed and boastered lines neatly axed off with a scotch (sometimes term scutch).

One must also remember that not all bricks used for gauged arches were as soft or cut as easy as rubbers, so the cutting box and wire-bladed bow-saw method would not be appropriate for them. Malm cutters and Suffolk clippers respond better to fine 'axing' and abrading to achieve the required precision; though, by this time, their popularity was waning against the orange/red-coloured rubbing bricks. The plate of an Edwardian bricklayer's tools given by Mitchell and Mitchell (1906, 86) shows the scutch, chopping

block, wire bow saw, and moulding box that allowed for the cutting of both rubbers and cutters. (Figure 80).

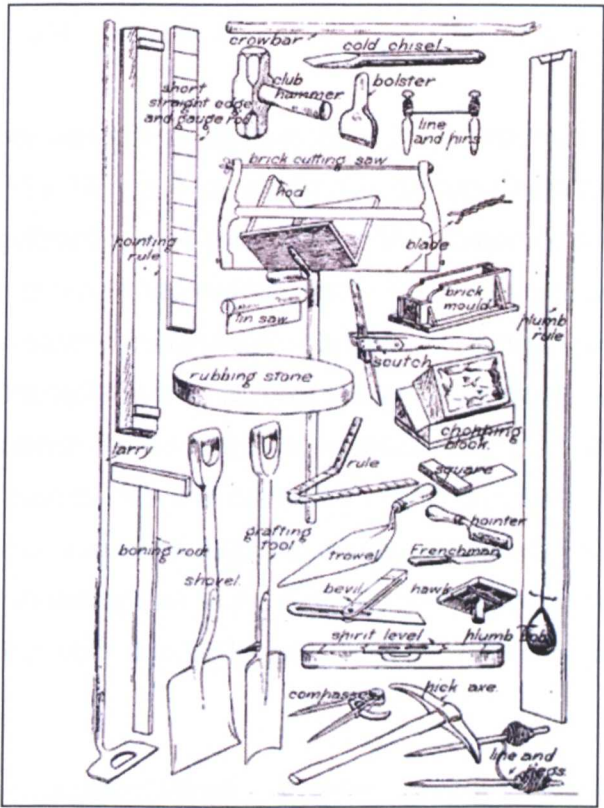


Figure 80 Bricklayers tools from Mitchell's Building Construction and Drawing, 1906.

Certain brick companies, such as Johnson and Lawrence, produced their rubbers to larger sizes, which made them better suited for the cutting box and wire-bladed saw method. Oversizing was sometimes resorted to historically for certain architectural requirements, possibly when the bricklayer was also the brickmaker and able to make a positive case for doing so. Johnson's Fareham rubbers, intended for carving were oversized, as can be seen in the poster of Johnson of c.1880, (see Figure 70); the bricks being priced 20/- [£1.00] more per 1,000 than for the smaller size rubbers.

Even the smaller sizes of rubbers, however, could be larger than the Royal Institute of British Architects (R.I.B.A), standard face brick, as can be seen in the sizes being offered by Lawrence for their TLB rubber range in 1898:

- $12\frac{1}{2}$ x $4\frac{5}{8}$ x $3\frac{1}{8}$ ins - (248 x 118 x 80 mm)
- $14\frac{1}{2}$ x $4\frac{5}{8}$ x $3\frac{1}{8}$ ins - (368 x 118 x 80 mm)
- $12\frac{1}{2}$ x $7\frac{1}{2}$ x $3\frac{1}{8}$ ins - (318 x 191 x 80mm)
- $9\frac{1}{2}$ x $9\frac{1}{2}$ x $3\frac{1}{8}$ ins - (242 x 242 x 80 mm)

The smallest rubber was still larger than the typical contemporary face brick, then generally 229 x 115 x 76 mm. The largest rubbers were intended for use as either long voussoirs on deep-faced arches (especially the long springers in a camber arch) or for deep 'tailing-in' on cut-moulded oversailing courses using headers, as well as for carved enrichments. Most other companies continued to make their rubbers to the standard size. This also remained true of malm cutters, the production of which ended with the rapid decline of London Stocks due to competition from the Fletton industry at the close of the nineteenth century. Several companies continued supplying rubbers as green-moulded (over-sized) voussiors requiring only rubbing to create flat surfaces with sharp arrises, 'topping and tailing' (cut to the required intradosial and extradosial bevels); and the dummy joints correctly applied to create the desired face bond.

2.5.5 Setting the Gauged Work – Ashlar, Arched, and Carved

To produce joints of such fine measurements the substance of the bedding material must be reduced to a very fine state of division. In normal gauged work pure slaked lime known as putty is the material employed.

Precision in the cutting of gauged arch voussoirs, allowing them to lock together in a very accurate and close-fitting manner, provided strength for the element, so a low strength mortar, based on a non-hydraulic chalk-lime binder could suffice. Generally, though as Hammond (1875, 45) emphasises 'Gauged arches, as a rule, are set in grey lime putty, brought to the consistency of cream'.

Hammond's old term of 'grey lime' refers to the feebly hydraulic class of lime, a highly workable lime capable of an internal set and long-term carbonation. Sometimes written as 'greystone', 'grey chalk' or 'stone lime', it was the favoured building lime, especially in the city, since the seventeenth century. Walker (1885, 14) emphasises the correct choice of building lime, warning:

Mortar used by the bricklayer is made either from stone lime, lias or Portland cementChalk lime should not be used, as the only setting that takes place in it is the formation of a surface crust, bearing a small proportion to the bulk....Stone or gray chalk lime, as it is sometimes called, is generally used...

In reference to setting gauged work, Walker (1885, 63) states:

Stone lime should be used for setting, as chalk lime is not fit for out-door work.

Putty for gauged work would normally be prepared in a galvanised tank by part filling it with clean water (fit for drinking) and gradually adding lumps of quicklime. In the initial stages the water would bubble and boil furiously. The whole mass stirred continually with a larry (a special tool like a hoe) until it was a thick creamy fluid. The slurry would be passed into a another tank at a lower level through a finely meshed sieve, Richards (1901, 39) states ' the joint should be $\frac{1}{32}$ " [1 mm] only in thickness, hence the sieve should be at least 400 to the square inch'. Once this phase was completed the putty was covered with water and left to stand for several days to mature and ensure that there are no unslaked particles of lime.

The matured putty was then placed within the dampened 'dipping box', or 'putty tub' being 'an oblong wooden box, about 2 ft. by 1 ft. 9 in. deep, for the setter to dip that side of the brick where the bed-joint is required' (Hammond 1875, 45)

Setting gauged work on site required great care and skill so as not to spoil the preparation of the enrichment that had been undertaken in the cutting shed. Hammond (1875, 44) states:

... it must be remembered that, after the work is cut, there is almost as much skill required in setting it. For it very often happens that a vast amount of labour and skill is expended upon work while in the "cutters" hands, and directly it is taken on to the building the beauty of it is all destroyed through the carelessness or inability of the setter...

Historical texts can sometimes read as if gauged work was set with lime putty only, and the term 'putty joint' is still used today, but this is mis-leading. The putty was almost always mixed with silver sand of appropriate grade, creating a fine mortar like a plaster's skim coat; indeed it was sometimes referred to by their own craft term as 'fine-stuff'. Without the addition of sand, one loses mechanical strength, greatly increasing the likelihood of the joint cracking during drying-out and long-term failure.

Walker (1885, 63) describes laying or 'setting' once the rubbers have been soaked - but not saturated - to remove their excessive porosity:

...the joint is taken up by absorption by holding the bed of the brick in contact with the putty, which must have the proper consistency and be kept in a small putty-box made with a level top, so that the setter can rest or steady his arm upon it while "dipping" his brick. Before putting the brick in place, the putty is scraped off the middle of the "bed" that it may set or joint more evenly. The joint should not be touched after the brick is "bedded" but should be left full like a small bead. Stone lime should be used for setting, as chalk lime is not fit for outdoor work.

For completed arches, accepted best practice was to pour a stronger hydraulic lime: silver sand grout into 'joggle-joints' (cavities cut, or filed, into the opposing beds of voussoirs) once the arch was 'turned', to increase its strength. Later in the period Portland cement was increasingly preferred for grout due its to speed of set and strength. Grouting with Portland cement was sometimes employed at the rear of work to be carved *in situ*, as Walker (1885), 63-4) indicates:

If the work has to be carved deeply, it is best to build it all "headers", and "grout" it in solidly at back with Portland cement, that the bricks may not break up or get disturbed under the chisel of the carver.

Generally, where strength of the bedding matrix was important (such as for door reveals, on projecting oriels, or *in situ* carved enrichments), a different mortar was necessary. Not the hot or cold cements of former days, but instead, as Walker (1885, 64) explains:

A composition of whitening [whiting] and patent knotting is more frequently used than lime-putty for bedding or setting work intended to be carved, and for ornamental key-blocks made up of two or more bricks. It will be found most convenient to put such keys or blocks together in the cutting-shed, and take them upon the building to be set as one piece of work. These remarks apply equally well to the niche hood in every particular.

'Whitening' or 'whiting' is simply finely crushed chalk. The need for a shellac-based medium, such as 'patent knotting', is emphasised by Richards (1901, 86-87) with regard to carved gauged work:

Gauged brickwork is a most admirable material for carving, the soft effect produced being quite equal to that of modelling.

The bricks, having been perfectly squared and the projection arranged, are set in a mixture of dried or baked white lead and liquid shellac; being at the same time rubbed together to form a tight joint. Carved brickwork may in this manner be made to stand out in relief as

much as 18"; but when this is the case the work should be arranged from a model, the different projections being taken from this and the work set accordingly...

White lead or whiting give body and pigment to the finished joint and appear similar to one of lime putty and silver sand. Shellac sets hard, imparting the desired strength to such a mix, being defined by Jennings and Rothery (1936, 35):

Lac is a natural resin which exudes from a number of trees.... Stick lac is crude resin. Seed lac is the first result of refining the crude resin. Shellac is the usual commercial form; it is received in thin sheets...

Information provided by Hillary Miller, laboratory technician at Liberon Waxes, indicates that commercially-produced shellac really began in the Victorian period as 'the industrial revolution of the early nineteenth century ensured an increasing need for gum lac as a colouring dye and an adhesive' (Miller, 2001).

Bricklayers of this period were quick to realise the potential of shellac to firmly unite their rubbing bricks. The occasional need to glue bricks together led to the craft term of bricks being 'shellaced'. Where the glue joint between bricks was not going to be seen, then just pure liquid shellac was used.

For an ornamental 'blocked' keystone - of three or five voussoirs joined together - the rubbers would be dusted, dampened, and then set with white lead or whiting and shellaced. These would be laid individually to the designed bond on the bedding slate and quickly tied-off with wire or string, with appropriately placed thin timber packings to protect the vulnerable arrises. Once fully set and dry, the block, or lump would be placed in the appropriately profiled large moulding box, and then cut and rubbed to shape using the wire-bladed bow saw, and finished with chisels, files, and other relevant abrasives. Sometimes the flat or camber arches were constructed by this method (Mitchell and Mitchell, 1906, 71):

The voussoirs are jointed together on the surfacing slate, either into the complete arch or into convenient sections the back of the joints being grouted with Portland cement. In setting the arch it can be placed *en bloc* on the turning piece and between the skewbacks prepared to receive it, or if large, the various sections are jointed together on the turning piece, in which case the exact position of each brick must be marked thereon.

This block or lump method was also used to cut and shape a globe as a terminal feature on an isolated pier, and also for turning in a box (as if on a lathe) bonded gauged vases (Figure 81) for use on classical gables and pediments (Hammond, 1889, 72).

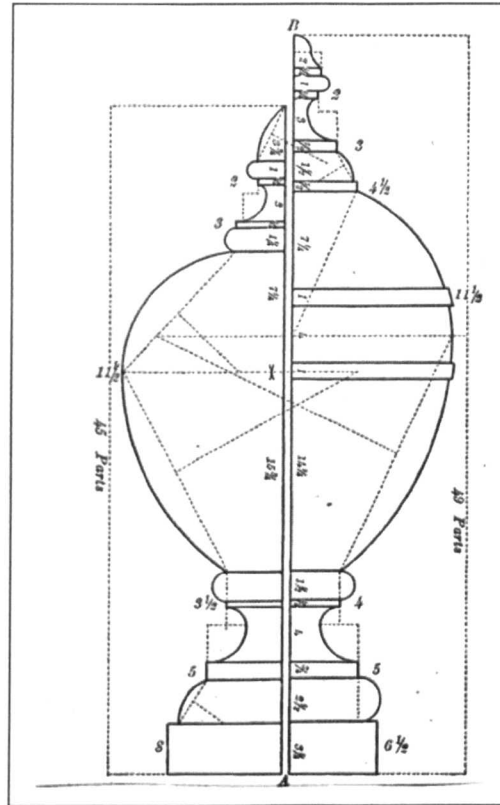


Figure 81 Drawing of how to set out gauged vases to be turned on a lathe.

When using white lead or whiting with liquid shellac in the form of patent knotting, the former is always added to the latter, stirring continually to a cream-like consistency. Traditionally this was done on a slate or stone slab until fully integrated, and trowel-applied to the prepared rubber. The brick would then be laid to position to exude a thin bead of joint, allowed to dry sufficiently, and then neatly cut off flush without staining the work; in readiness for full rubbing-up once the work dried.

Where *in situ* carving work was to be undertaken as part of an overall enriched detailing Walker (1885, 83) explains:

It is the work of the bricklayer to cut and form all kinds of mouldings, dentils, entasis columns, flutings and such-like members in gauged work, leaving the more intricate, such as design and foliage, to be executed by the carver.

By the second half of the nineteenth century city trade carvers, who could work in brick, stone or wood, were commonly employed by large companies like John McCulloch of Kennington, London, rather than be self-employed. The trade carver Mr. Heam, who

carved all the decorative gauged work on the block of offices erected at the corner of Chancery Lane and Southampton Buildings, London, in 1879 was one such person (Figure 82).



Figure 82 Drawing from 'The Architect', of the offices at the corner of Chancery Lane, London, displaying carving skills on gauged work panels by Mr. Heam 1879.

McCulloch's craftsmen carried out much of the exquisite *in situ* carved gauged work on the many Queen Anne styled properties around Chelsea and Cadogan Square as well as the stylistic development (humorously titled 'Pont-Street Dutch' buildings) of the later period around the Kensington and Knightsbridge areas of London. 'Pont-Street Dutch' was, supposedly, based on Flemish Renaissance architecture fashionable in the 1880s, making much use of panels of gauged brickwork, elaborate gables and strapwork. One of its most successful protagonists was Sir Ernest George (1839-1922).

According to the London Post Office Directory of 1885, John McCulloch was an architectural modeller working out of 384 Kennington Road; where they were in 1890 but then listed as an architectural sculptor. In the 1899 edition, the listing is for J. McCulloch Ltd, Sculptors and Modellers, Monumental Masons, Woodcarving etc, at a new address of Harleford Mews, Magee Street, Kennington Park. Perhaps as a reflection of the architectural changes following these years, the company is listed as J McCulloch Ltd, Fibrous Plaster Decorators in the edition of 1910.

2.5.6 Measuring Gauged Work

With regard to measuring gauged work at the beginning of the nineteenth century Pasley remarks that ornamental parts of the work are, like the earlier periods, charged extra and by different methods to standard walling and lists them. Removing that not related to gauged work, his list reads (Pasley, 1826, 251-52):

3rd. Gauged and rubbed arches. These are measured in superficial feet, according to the area of the figure contained between the intrados, the extrados, and the extremities of each.

4th. The points of groined arches. These require bricklayers of more than usual skill, and are very troublesome. They are measured by the lineal foot.

6th. Rubbed splays. These imply the fitting of the brickwork over the extrados, and on each side of the skewbacks or gauged arches, and all other oblique work...to be cut but rubbed....it is measured by lineal measure along the outline of all the curved or oblique lines....

8th. Rubbed splays to angles. Rubbing as well as cutting is necessary when those splays appear on the outside of an ornamental brick building, as in angular bows. These angles may of course be salient as well as re-entering, and are also measured like the former, by the lineal foot, but are paid at a higher rate.

12th. Cornices or other mouldings set in putty. These are charged by superficial measure, not by taking the net height, as it would appear in the elevation of a building, but by straining a line over all the projections, and into all the cavities, so as to embrace the whole outline of those mouldings, as they appear in profile.

Hammond (1875, 114) is typically succinct on the same:

All gauge-work is measured by superficial measurement (unless otherwise specified); and every part that is exposed to view is taken in the dimensions.

Skewbacks, birds'-mouths, splays, beads, &c., are generally measured by the run. But if measured as gauge-work, it is usual to ply the tape or a piece of string, close to every part of the brick that is moulded, and afterwards measure it to get the whole of the girth of the work, and this is multiplied by the length for the contents.

Arches are also measured by the girth multiplied by the length.

This practice of measurement for gauged work remained essentially the same throughout the period. A factor never mentioned, but with a large impact on price, was fineness of the joints - the tighter, the more expensive - as the cutting, preparation, and setting had to be of the highest order.

2.5.7 The Use of Gauged Brickwork in the Revivalist Styles

On the use of gauged brickwork in the revivalist styles, Walker (1885, 14 -15)

comments:

Owing to the revival of the Queen Anne style of architecture, brickwork now occupies the foremost position in building construction.... Our popular architects delight to revel and indulge their fancies in red brickwork, as evidenced in several public buildings of recent erection.

Walker (1885, 79), elucidating still on the proliferation of ornamental brickwork and defending it against its critics, suggests:

Ornamental brickwork in this country has reached its greatest height in connection with the Queen Anne style of architecture, as elaborated in the present day. The oriel windows of the Tudor, the ornamental gables and picturesque chimneys of the Elizabethan, are all merged into it, and with such a profusion of carving as to be unprecedented in any former age...

Walker is writing during the height of the High Victorian period when London was a mass of building activity. Many architects were designing wonderfully crafted brick facades, allowing master craftsmen the opportunity to display their skills in a manner not truly seen, or indeed desired, since the late seventeenth century. Combined with the rapid developments in associated building technology - such as the use of brick reinforcement – there was an unbridled renaissance of gauged work.

This enthusiasm was fuelled by a conjunction of events such as the philosophy of the Arts and Craft movement, dedicated and innovative architects, the rising pride of city craftsmen, and the entrepreneurial self-belief of the late Victorians for high standards and discipline. All was financed by the wealth of the British Empire and continued on into the Edwardian period, until cruelly terminated by the devastating effects of the First World War.

It was through the early Gothic Revival movement that the craft of bricklaying received its much-needed boost as the fashion for fair-faced brickwork returned, and with it gauged work detailing. The Midland Hotel, St Pancras Station (1868-74), by the architect Sir George Gilbert Scott (1811-1878) presents neatly moulded voussoirs to the arches of gauged work.

The use of Gothic vaulting was also re-introduced and there is an excellent example of gauged vaulting, with stone ribs, to be seen in one of the entrances to the Law Courts on The Strand in London (1882), designed by George Edmund Street (1824-88).

To truly assess how gauged brickwork was developed and used in a more novel manner during this period, one really has to look at buildings constructed in the so-called Queen Anne style, which was suited to gauged enrichments. Within this style proliferated all manners of arches, aprons, pilasters, columns, pediments, and niches, and a use of carved work, to an extent not seen before or since.

Not everybody was at ease with this Victorian version of Stuart brickwork, or fully understood the capabilities of rubbers to be perfect for post-fired working to shape

The Building News of 27th October stated (1871, 311):

Much as we admire it, we cannot help considering rubbed brickwork to be false in principle. There is no doubt that rubbing has been resorted to in some of the most beautiful work we possess; and we must admit the new buildings at South Kensington are most excellent examples of the judicious employment of red bricks. But we are convinced that as bricks are necessarily moulded in the process of manufacture, it is a mistake to tamper with and shape them after they leave the kiln. It is really doing the work twice over to cut them into fantastic shapes, as has been done in the window shown by Mr. Wm. Cawt, of Fareham, when they might have received these forms in a quarter of the time while the clay was in the plastic state. Besides, mortar joints are on no account to be despised, and 'improved' down to the thickness of a mere sheet of paper, as we see here. We should say, by all means use the brick with the natural surface it receives in firing, and give it a plain, honest bed of mortar. This has been done in the Albert Hall and in the new Exhibition buildings, and we venture to assert that the effect with gray mortar is better than the rubbed work at the Museum, which looks as if the joints had been ruled on with a drawing-pen.

Another aspect of this displeasure with gauged work can also be read in *The R.I.B.A. Journal* of 8th December 1892 (1892, 88) (this was repeated in *The Builder* of 26th January 1895):

...much of the modern brickwork in imitation of the Queen Anne style fills me with horror and detestation. When I see pilasters tacked on to a front which not only have an exaggerated entasis at their sides, but come bellying out in front like the sails of a ship, they remind one of the fable of the frog and the bull, and the bricks seem swollen with conceit at having attained to a form utterly foreign to their nature. And it is this, rather than the ugliness, which I so strongly object to. Brick is a hard material moulded and baked in a kiln, and moulded bricks seem to me perfectly legitimate; but surely the original baked surface is the most fitting to resist the weather; and if you go and rub and cut all the surface off, and then give the material a shape and form utterly foreign to its nature, you are completely reversing the practice of the Mediaeval builders, who have left us the most magnificent examples of their skill, and who invariably gave to each material they employed the ornamental treatment that it was best fitted to receive.....

Clearly the writer knew nothing of the prolific practices of the medieval hewers and their legacy of magnificent post-fired enrichments, or that baked rubbers differ from well-fired bricks.

The differences in this revivalist fashion were not only the stylistic and design conundrum and use of traditional enrichments, but also the impact of changing technology behind their constructional use. This is immediately apparent in the quality of rubbers over their seventeenth and eighteenth-century predecessors, giving features a much more homogenous appearance in both colour and texture. It is especially noticeable on high-quality work where colour-matched rubbers could be insisted on, ensuring no variation in quality, texture, or tone; this can cause the gauged work to appear less organic and sincere than the best work of the periods it seeks to emulate.

Over-sized rubbers have a dramatic impact, as architectural features are being formed from individual units much bigger than was typical before. Arches of this period are frequently set-out to a larger brick gauge at the extrados (due also to different setting out techniques employed from earlier periods), resulting in less voussoirs to an arch face of comparable span to one from the previous periods; this can give a rather heavier appearance to the arch. Oversized rubbers could facilitate certain detailings more easily than smaller bricks, such as the rusticated semi-circular arch as at Eastney Barracks in Portsmouth (Hampshire) (Figure 83). Here, the oversized voussoir bricks of the arch extrados were capable of being cut to special individual shapes in order to link the varying radial lines with the horizontal offsets of the blocks.

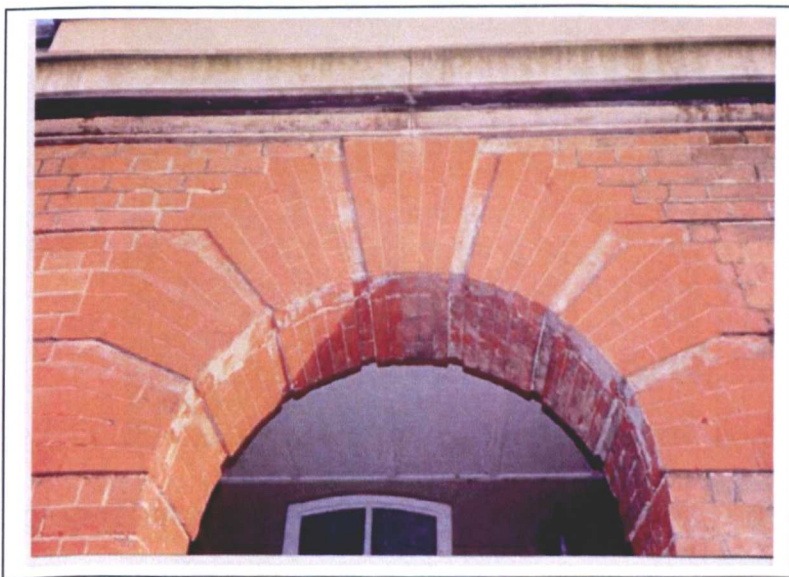


Figure 83 A rusticated semi-circular gauged arch at Eastney Barracks, Portsmouth (Hampshire), 1871, showing the aesthetic effects of larger rubbing bricks.

Carving gauged brickwork was benefiting from new techniques in washing and screening the brickearth and clay, making rubbers cleaner-bodied and more homogenous, so allowing easier and deeper carving with sharp arrises and greatly reduced unwanted inclusions spoiling the carver's work. This facilitated a plethora of

brick carving, on all forms of architectural features, to unprecedented levels, as displayed at Newnham College Cambridge (c.1875) (Figure. 84) and the exquisite bullseye arched windows to Holywell Hill in St Albans (Hertfordshire) (1911) (Figure 85).



Figure 84 Exquisite carved gauged work at Newnham College, Cambridge, c. 1875.



Figure 85. Carved bullseye arched window, Holywell Hill, St. Albans (Hertfordshire), 1911.

These qualities also allowed rubbers to be exploited for enrichments previously unseen in gauged work, such as a sphere or globe to a pier capping on the gated rear entrance to Emmanuel College, Parker Street, Cambridge, (1894), designed by the architect J. L. Pearson (1817-97) (Figure 86).

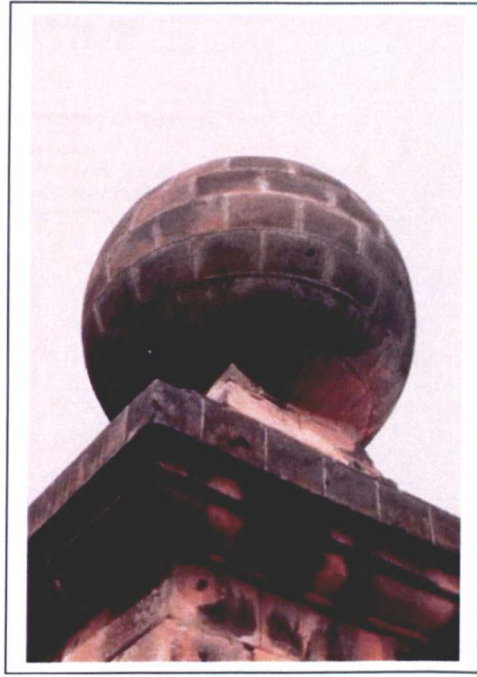


Figure 86 Gauged pier capping with globe, Emmanuel College, Cambridge, 1894.

The development of reinforcing brickwork by laying lengths of tarred and sanded hoop-iron into the beds of every fourth or fifth course was also used on some gauged work. In such instances the rubbers had channels rubbed into their beds to accommodate the reinforcement and not interfere with the tight jointing. The row of cut-moulded gauged consoles, constructed of TLB red rubbers and supporting verandas, at R. Norman Shaw's (1831-1912) Albert Hall Mansions, in Kensington, London (1892), are a reinforced deceit; otherwise they could not accommodate the loading they carry (Figure's 87 and 88).

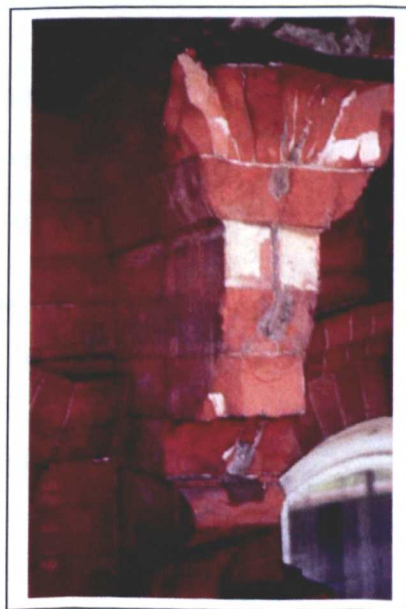


Figure 87 Console revealing rust damage from reinforcement to gauged brickwork, Albert Hall Mansions, London, 1882, (Mike Stock).

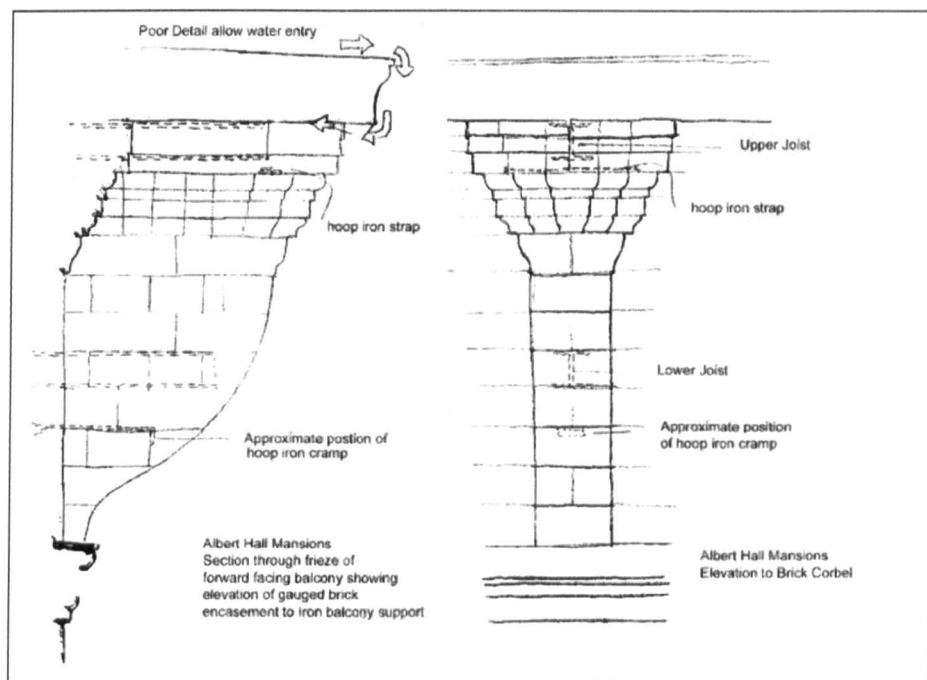


Figure 88 Drawings showing the hidden ironwork within a gauged console, Albert Hall Mansions, London, 1882, (Mike Stock).

Former English Heritage architect, Mike Stock, tasked with the repair of consoles damaged by the expansive effects of rusted reinforcement records (Stock, 2002):

The 'brick' corbels supporting the lower balcony are false, however, and the support for the balcony slabs is vertically separated pairs of wrought iron or rolled steel joists embedded into the elevation, with brick packing between the two joists. The composite brackets were then encased with gauged TLB rubber work, which incorporated hoop-iron cramps in the approximate locations shown on the sketches [Figure 87]. Poor detailing of the balcony 'drip' allowed water to run over the balcony front and into the joint between the underside of the balcony, and the top of the brackets. This resulted in corrosion of both the supporting joists, and the upper cramp, with inevitable oxide 'jacking', causing serious damage to the gauged work, as can be clearly seen [Figure 88].

A further problem noted was that the calcium of the limestone balcony was taken into solution by the aggressive acid atmosphere. Re-crystallisation of the sulphate salts within the face of the soft rubbers was causing serious blistering and exfoliation of the brick face too.

The architect George Devey (1820-86) utilised reinforcement in the form of 12 mm diameter iron rods passed through holes drilled through the lengths of cut-moulded stretchers, on the deep overhanging cornices, at Minley Manor in Aldershot, (Hampshire) (1886-87). This technique only became visible as a result of the expansive effects of rusting leading to the loss of part of a brick face (Figure 89).



Figure 89 Exposed iron reinforcing rod within a gauged cornice, Minley Manor, Aldershot (Hampshire), 1886-87.

Summary

The gauged work of this period, particularly during the second half of the nineteenth century, was greatly influenced by advances in technology. Developments in the washing and screening of brickearth and clay led to the manufacture of cleaner-bodied rubbers, fired in improved and more controllable kilns, and distributed to a wider market, via the national rail network. The introduction of the twisted steel wire blade for cutting rubbers within profiled cutting boxes increased both accuracy and speed. A wider range of products to fix and support the finished gauged work than was previously available led to new architectural uses. The fashion for gauged enrichments returned in a highly adventurous manner due to various architectural revivalist styles that benefited from the national desire to educate building craftsmen to undertake hand-crafted work of the best quality.

2.6 1918 TO PRESENT

This period has witnessed remarkable developments and scientific achievements providing fresh approaches to architecture that utilise new constructional materials and methods so creating styles of their time. This has partly resulted from collaboration of architects and engineers in resolving building problems. Previously:

Designers who thought in terms of technology became the engineers; those who thought in terms of academic aesthetic formulae became the architects, and no love was lost between what soon became the two opposed modes of thought. (Penoyre and Ryan, 1958, 155)

Their collaboration and the new technology they had (and continue to have) allowed them to break away from applied period styles that had become the accepted meaning of architecture, as Penoyre and Ryan continue:

...these men reverted to first principles and a dogmatic adherence to the functionalist ideal, believing that if a thing was truly fitted to its purpose it must necessarily be beautiful.

A new philosophical background underpinned architecture of the twentieth and early twenty-first century, and thereby the new breed of craftsmen, with an emphasis on putting forms into shape. It can be argued that this movement re-vitalised architecture, producing our modern streetscapes, but overlooked principles of form, proportion, and texture, was the result of a singular concentration on functionalism. Traditional materials such as brick, stone, and timber, continued to be used, but usually with different applications, and in conjunction with new materials - plastics, rubber, and aluminium - alongside steel and concrete.

These materials were produced in whole or part in highly automated factories. Their individual properties were better understood and their performances under loading and climate calculated so that no more material than necessary was used. This final point is of significance, as it led to standardisation that is normal today. The consequence of all this was, and remains, the loss of superfluous ornamental architectural decoration and the demise of associated skills. In terms of structural brickwork, gauged work was dismissed as an unnecessary and highly expensive extravagance.

2.6.1 Twentieth-Century Brickwork – A Time of Great Change

Building sites changed rapidly as the twentieth century progressed, especially in the towns and cities where machinery and motor-driven tools began appearing and tubular steel scaffolding replaced timber. Site congestion reduced extensive on-site workshops such as the bricklayer's cutting-shed.

Architectural changes reflected social responses about how future housing should be built, responding to the alarming findings on the overall level of poor health of the nation's young men when conscription started in 1916. Inadequate and inferior housing was held largely to blame, and the resultant Tudor Walters Committee report of 1918, set down minimum standards for workers houses constructed during the inter-war period. This served as the foundation for other standards for a long time after.

Externally, structural brickwork reflected these changing times. Though solid-wall construction dominated, the true cavity wall was increasingly used, and cement was being added to lime mortar for both increased speed of construction and also additional strength for thinner walls. The general standard of brickwork achieved was good, and minimal enrichment was entertained to enliven principal facades, though usually along flat, angular, or recessed planes. This was achieved by the manipulation of standard bricks, creasing tiles or, more traditionally, with axed arches of soft stocks neatly finished with precise, mainly 'weather-struck and cut' pointing.

Regular mechanised bricks on principal facades removed the need for the traditional colour washing and tuck-pointing, or the precise cutting and rubbing of ashlar gauged work. It became increasingly difficult for the discerning architect to argue in favour of gauged work because the overriding aim was to achieve quality of construction, but at minimal cost. When it was employed, usually for a simple arch, the high standards only a generation before was increasingly relaxed as a fashion for a wider joint prevailed; perhaps as a result of the overall loss of those finer skills. This killed off any remaining remnant of William Morris's ideals of a handcrafted Britain that was viewed by architects and planners as a luxurious deceit that was simply too expensive.

As Quiney (1986, 145) records:

'The standard cottage will depend for any attraction that it may possess, not upon the tool marks of the workman, nor upon its peculiarity or idiosyncrasy, nor in a word upon its individuality', wrote the planner and architect Stanley Adshead in 1916, 'but upon more general characteristics such as suitability to purpose and excellence of design.'

Some simply disliked the use of gauged brickwork *The Brick Builder* of March 1927 reported (1927,44):

I hold, for instance, that it is not possible to imagine a kind of bricks nor a manner of using them more entirely delightful for their purpose than is to be seen in the elevations of Sir Edwin Lutyens' Midland Bank in Piccadilly. Here, again, we have bricks; not bits of soap, or blocks of cheese, or nougat or chocolate, but real bricks; and they are in those walls, disposed as an understanding craftsman would dispose them. It is only necessary to imagine the same design rendered with rubbed flat arches, quoins of the same fashion, and a uniform close-jointed, neatly-pointed panel work, to realise how important for all brick architecture is the use of bricks which expressed the nature of bricks and a sense of them as fashioned by men's hands from clay dug from the ground and burnt hard; and the employment of right unaffected bricklaying craft, which scorns to form finer joints than the bricks and mortar make appropriate....

This writer sees honest artistry in the craft of brickmaking, but not when applied to a bricklayer crafting a rubbing brick as a mason his stone. Would he have stone never worked, but laid only as it was quarried and believe that honest? Like everything, it is a matter of knowledge, perception, and taste.

By the 1930s decorative brickwork declined in popularity as the fashion for Art Deco pushed designers towards rectilinear forms. Brickwork became increasingly functional, with openings spanned by lintels exposed on face or standard bricks laid upright as 'soldiers'. English and Flemish bonds remained common, even for the increasingly popular cavity walls utilising snapped 'bats' to achieve the appearance. Stretcher bond became ever more acceptable as the 1930s progressed and the increased use of stronger cement mortars with 'jointed' rather than 'pointed' finishes. Undoubtedly the craft of the bricklayer and the use of brickwork were undergoing a subtle, but nevertheless substantial, transformation.

2.6.2 The Post-Second World War Period

The Dudley Report of 1944 led to the publication of the *Housing Manual* by the Ministry of Health and Ministry of Works, which laid down minimum requirements of post-war reconstruction for strength, stability, thermal and sound insulation, and resistance to

damp and fire. This influential publication became the guide for all subsequent standards in house construction for many years.

The very influential government report, *Government Houses for Today and Tomorrow*, prepared under the Chairmanship of Parker-Morris, was published in 1961, and set the 'Parker-Morris' standards of construction. The Building Regulations of 1965 (revised several times since) became a system of controlling the planning and construction of buildings throughout England and Wales replacing various local bye-laws in operation since the Public Health Act of 1875. Research, commercial, and professional bodies also contributed to the development of the style and use of masonry to meet contemporary demands; the National Housebuilder Registration Council (NHBC), Building Research Establishment (BRE) (formerly the Building Research Station, BRS), British Standards Institute (BSI), British Ceramics Research Institute (BCRI) and the Brick Development Association (BDA) being the most influential.

From a bricklayer's perspective new constructional practices emphasising economy of material meant that brickwork underwent dramatic changes directly affecting traditional craft practices and, with it, much of the rich heritage of the craft. Brickwork became functional as simple rectangular buildings, and was shorn of architectural enrichment. Cavity walls of brick, and later of brick and block requiring quick-setting and rapid strength-attaining cement mortars, superseded solid walls laid with slow hardening lime-based mortars. There was a loss of various bond patterns and universal use of stretcher bond, all the more severe on the eye because of the general acceptance of less aesthetically appealing machine-made facing bricks. Regional variations in brick size, type and use completely disappeared particularly with the standardisation and metrication of brick sizes in the 1960s, which formed part of a movement towards modularization. Allowing for dimensional co-ordination using standard components and assemblies.

This was a rapid, changing, and cost-driven environment, manifesting itself in an ever increasing site acceptance of general poor standards of work, and where traditional crafting skills became increasingly supplanted by standardised national fixing practices. Gauged brickwork, as the highest expression of the finest skill and knowledge of traditional bricklayers, was fast heading for extinction.

This dramatic demise of bricklayers who were skilled in gauged brickwork was highlighted in *The Brick Bulletin* of March 1954, where there was a need to rebuild gauged enrichments on the bomb damaged late nineteenth-century church of Our Lady of Grace and of St Edward in Chiswick (London) (Plaskett Marshall 1954, 4-5):

Rarely today does an architect have an opportunity of designing in rubbed brick. In general, it is probably true to say that contemporary architects do not seek such opportunity, and if a client asked for a new building with walls of rubbed brick and window heads in gauged work, the architect would not encourage the whim; his reasons would be sound enough. First, the cost of material and labour would be high. Second, contemporary fashion is out of tune with the kind of elevational effect, which can be produced with rubbers....

....The walls were faced externally with red rubbers, carved in the cornice and frieze and with wall panels which, though apparently intended for carving, were never finished. The general treatment was classical, with external pilasters of rubbed brick with Corinthian-type capitals carved from the same material. [Figures 90 and 91]



Figure 90 Carved brick capitals set in a frieze of rubbers, at The Church of Our Lady of Grace and of St Edward, Chiswick, London, from The Brick Bulletin, March 1954.

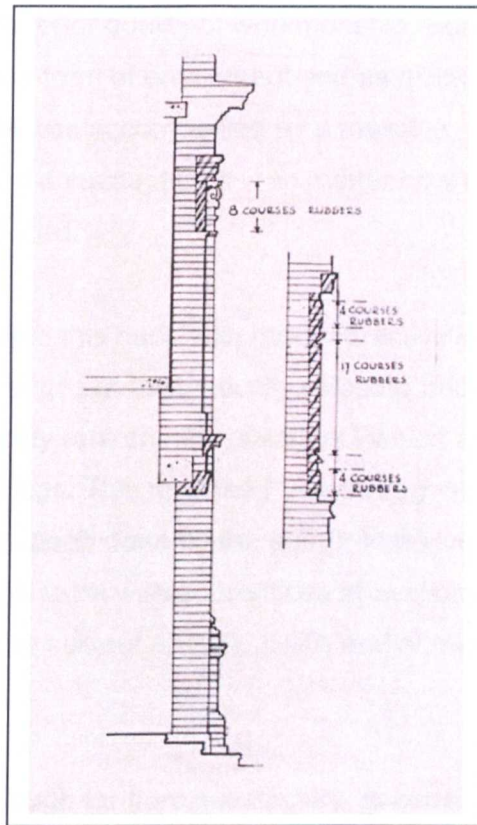


Figure 91 Sectional detail by Plaskett Marshall showing the gauged work as a half brick skin to the overall brickwork at The Church of Our Lady of Grace and of St Edward, Chiswick, London, from The Brick Bulletin, March 1954.

The architect for this project was Plaskett Marshall, who records for the benefit of others who may undertake such restoration or carved work (1954, 5):

...The carving of the rubbed brick capitals presented certain problems and the sculptor, Mr. Joseph Cribb, encountered difficulties caused by hard nodules which occurred in the bricks themselves. The importance of very careful filling of all joints for work which is to be carved cannot be overstressed.

Each capital took approximately ten days to carve, after much time had been spent in setting out to avoid leaving bricks undercut and to ensure that the perpend matched on each leaf of the capital.

The article concludes by expressing the following viewpoint:

Whether rubbed work will ever be extensively used again is problematical. Fashion is unpredictable. There can be little doubt however that for relatively small areas in the right setting rubbed brickwork has great potentialities. In an age when so many designers are using drab exterior finishes, despite the wide variety of coloured materials available, it would be pleasant to see here and there the splash of strong colour, suitably relieved by carving, which rubbers make possible.

The building booms in the 1960s and '70s served only to hasten the decline in the knowledge and practice of traditional skills and when gauged work was employed,

increasingly it was of an inferior quality of workmanship. Building houses with machine-made bricks, devoid of any form of enrichment and as quickly and cheaply as possible was the primary aim. This was accompanied by a massive increase in unqualified men working as bricklayers and an acceptance – no matter how reluctant – of the inferior work they inevitably produced.

The 1980s saw a reaction to this nadir with more attractive designs and detailing of buildings with improved ranges of aesthetically pleasing bricks and special shapes. Gauged work was extremely rare on new buildings viewed as an old skill, for use only on the repairs to old buildings. This remained true throughout the 1990s and remains so today (in 2004). Much has been done by the author to revive the knowledge and skills of gauged work through his work with apprentices at Bedford College from 1987 to 1992, his publication on the subject (Lynch, 1990) and numerous other works since then.

The present situation although far from satisfactory, is certainly much more enlightened than one could dare to have hoped for 20 years ago. Some good work is now being achieved in gauged work, which even occasionally features on new properties once again, such as the large extension to a fine Edwardian country residence, Quakers, in North Crawley (Buckinghamshire) designed by architect Charles Morris in 1998. The two time-served, qualified bricklayers, Jeff Day and Darren Clark, who undertook the brickwork, had not had the opportunity to learn gauged work, but with on-site tuition by the author, were able to proceed with the enrichments to a very high standard (Figures 92 and 93).



Figure 92 Gauged work under construction at 'Quakers', North Crawley (Buckinghamshire), 1998 (Jeff Day).



Figure 93 Gauged work dressings at 'Quakers', North Crawley (Buckinghamshire), 1998, (Jeff Day).

Despite concerns of costs, the future for this highly-skilled branch of the craft has great potential, providing the investments of time, education, and finance are put into the aspiring craftsmen bricklayers, the relevant brick companies, and those responsible for both modern and historic brick-built buildings.

2.6.3 Brickmaking – A Changing Rubbing Brick

The two kinds of brickmaking - traditional hand-made and mechanically produced - have continue to co-exist throughout this long period although the latter has expanded rapidly at the expense of the latter. This has had inevitable effects on the production, quality, and variety of rubbing bricks available.

Many rural brickyards did not re-open after the First World War despite, the recovery of building activity. Almost all the traditional brickyards who had made their own rubbing bricks gradually scaled down production, or stopped altogether, due to the huge reduction in demand for decorative brickwork. However, the construction industry, in general, grew rapidly, assisted by large amounts of government aid intended to help house returning soldiers and to revitalise industry. The brick industry was prosperous during this period, and saw substantial re-investment. Many large firms replaced steam

power with electricity, and the introduction of petrol lorries for brick deliveries meant not only the end for the horse and cart but also less reliance on the railways.

The Second World War once again brought the closure of brickyards, but thankfully, the government and the brick companies had learnt from the First World War and developed a financial scheme to ensure funding for re-opening after the cessation of hostilities. It was at this time the Brick Development Association (BDA) was formed to administer these funds, its objectives being the research and education in the correct use of brick. Despite this help, many small firms were not to re-open and in 1946 there was estimated to be 1,350 brickworks employing 40,000 workers, yet through mechanisation annual brick production continued to rise (Brick Development Association, 2003).

The decline in demand for rubbing bricks throughout the 1950s and on into the 1960s led to a dramatic reduction in the numbers of brickyards making them (albeit on an occasional basis to cater for a particular order) to just a handful. The main company supplying the wanted demand was Thomas Lawrence of Bracknell (Berkshire).

To encourage better constructional use of their rubbers and make up for the lack of on-site workshops and skills of setting out and cutting of arches, Lawrence offered a cutting service supplying camber, segmental, and semi-circular arches for on-site assembly. From measurements supplied by the architect or builder, they would draw the full-size arch, obtain templets, and cut the voussoirs using an electrically-powered bench-mounted Clipper disc-cutter (Figures 94 and 95) and rub mouldings within profiled boxes.



Figure 94 Cutting gauged voussoirs by bench-mounted disc-cutter at Lawrence's Warfield works Berkshire in the early 1950s, (M. Dumbleton).

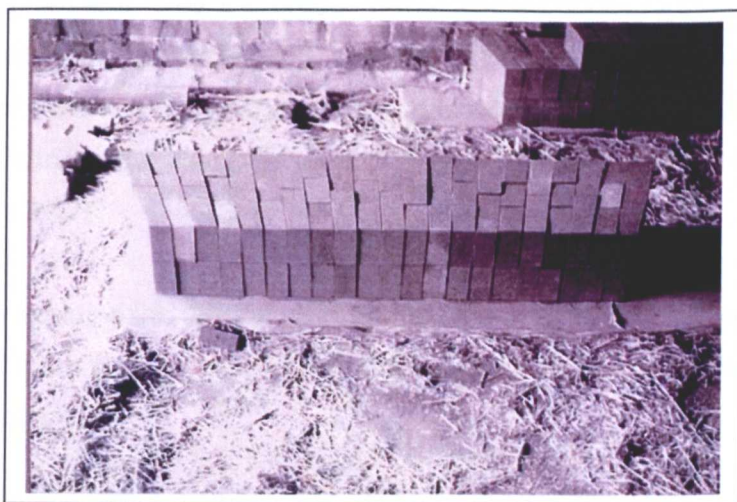


Figure 95 Disc-cut gauged arch sets of TLB rubbers ready for packing and delivery at the Warfield works of Thomas Lawrence (Berkshire) in the early 1950s, (M. Dumbleton).

These arch sets were numbered in order for laying and packed for site delivery.

Lawrence continued to offer oversized bricks for bespoke cutting but increasingly it centred on an orange rubber sized to one format of 245 x 120 x 80mm, as opposed to the wider range once offered.

By 1967 there were only 531 brickworks, the biggest loss was in traditional brickmaking, which continued to decline, as the small yards were unable to compete with the more cost-effective big companies.

Thomas Lawrence finally ceased production in 1984, not only of their prized TLB rubbers, but completely. The company was refused local authority permission to open up a new pit on the other side of the road to their works, vital for continued production. A highly respected brickmaker who supplied quality rubbers that were a significant part of the best of English gauged work for over a century ceased to exist at the stroke of a planner's pen. Those who taught the author the skills of gauged work would remark that the quality of the post-war TLB's, though good, was not that of the bricks made in the pre-war years. Having, on many occasions removed, re-worked and replaced Victorian and Edwardian red and orange TLBs, this view is considered well founded.

The prestigious 'TLB' trademark was purchased by the traditional brickmakers W.T. Lamb and Sons, incorporating it into their existing rubber production at their Pitsham Works, near Midhurst (Sussex). Lamb and Sons also produced a yellow gault rubbing

brick complementing their range, at their Faversham works in Kent. They produced a TLB red rubber in several sizes and types - firmer bodied bricks termed cutters, primarily intended for machine-cut work, and the 'TLBHCP', a softer rubber for traditional bespoke work and for carving. The latter was originally developed for the repair and restoration of the Hampton Court Palace cut-moulded chimney stacks; hence the added initials 'HCP'.

Hyett (1992, 11) explains the difference in the formulation of both of these types of rubbers in relation to the eventual choice for re-building an ornate Hampton Court Palace chimneystack:

... we found that the least expensive method of procurement was to use a general TLB brick, the mechanical properties of which allow it to be substantially cut off site. The general TLB is very similar in appearance to the specially formulated TLB HCP bricks in current use at the Palace for chimney repairs, except that the ratio of washed clay to sand is reversed from the proportion 25% clay/75% sand (TLB HCP) to 75% clay/25% sand (TLB). This reversal of the ratio of the constituent materials gives a stronger brick, more resistant to attack by wind and frost and to arris damage. Whilst not so easy to hand-cut using a bow-saw, the stronger bricks could be squared in the dry state using diamond tipped saws, roughly shaped by grinding, reduced to template by hand-finishing and hand-rubbed/stoned after construction....

Writing in *Renovation* of June 1988, the architectural historian Dan Cruickshank describes how Lamb and Sons developed their services for the client, specialising in supplying bricks for gauged work (Cruickshank, 1998, 1-5):

Lamb's bricks and arches division undertakes to produce full-size working drawings, based on the architect's specification and requirements.... This service is especially valuable if the arch or detail is a repair for an historic building, for many mistakes in specification can be made by architects untrained in the traditions of rubbed and gauged brick construction.

The bricks to form arches, when the geometry has been agreed, are cut by machine saw with each brick being dimensioned according to a template derived from the full size working drawing....

However, moulded bricks – ovolo or scotia for entablatures or stringcourses – are still ground and rubbed, though the process is also now mechanised. But where tradition remains firmly unaltered is in the size and quality of the bricks used for cutting and rubbing....

The precision of the cutting allows for very fine joints in the manner of eighteenth century brickwork although Lamb's recommends 5mm or 3mm joints.

The latter remark regarding joint size is revealing. The lack of 'squaring' across the rubbers, to ensure surfaces at 90° to each other before cutting, and the inability of machines to cut to precise tolerances with mechanised blade oscillation, makes close

jointing impossible. It further recognises that most site craftsmen were insufficiently skilled to set-out and work to tighter tolerances.

From 1987, the author, as Head of Trowel Trades at Bedford College of Higher Education (BCHE), established contact with Robert Lamb, the owner of W.T. Lamb and Sons. Over-sized rubbing bricks and pre-cut arch 'sets' were provided to support the author's efforts to re-introduce gauged work back into the curriculum, Mr Lamb expressed deep concern over the dearth of skilled bricklayers to do justice to his company's products and welcomed the initiative.

During the same period respected traditional brickmakers Bulmer Brick and Tile Company Limited, based near Sudbury (Suffolk), began exploring the potential of reviving production of rubbers. The owner Mr Peter Minter, subsequently provided trial rubbing bricks for use at Bedford College in an arrangement that benefited both parties. The apprentices learned how to cut, rub and set enrichments, (see Figures 101 and 102) and Bulmer Brick and Tile Company Limited gained vital and on-going feedback on various test rubbers regarding hardness, inclusions, workability, and suitability of purpose.

The only other traditional brickyard making rubbers at that time was the Aldeburgh Brickworks of W.C. Reades (Suffolk), mixing their Chillisford clay with their own loam sand prior to over-wintering, for both standard bricks as well as rubbing bricks.

By the end of the 1980s there were only 205 brickyards, employing less than 12,000 people (Brick Development Association, 2003). A growing emphasis on environmental issues, with vastly decreased fuel consumption and waste emissions, was met with computer-controlled gas and oil-fired kilns and re-cycling of combustion products within the firing. The Brick Development Association (BDA), through its advisory centre and well-researched publications, supported these developments and promoted better use of well-detailed imaginative brickwork and more aesthetically pleasing ranges of facing bricks and associated green-moulded specials were introduced. By 2002, brickyard numbers had declined further to 116, owned by only 45 companies employing 6,692 people (Brick Development Association, 2003).

The revival of interest in English gauged brickwork in the 1990s offered a glimmer of hope to the traditional brickyards, unable to compete with the financial and marketing resources of the larger brick companies. Those with the correct raw materials could

concentrate on providing their unique type/s of rubbing bricks for the growing and relatively lucrative market in the repair and restoration of traditionally constructed buildings. In addition, the numerous extensions and new-building erected in conservation areas required complementary designs, materials, and practices that reflected their original surrounding properties. This proved moderately successful, though the on-going problem of sufficient skilled and knowledgeable bricklayers to do justice to the bricks produced was, and remains, a serious and constant concern.

2.6.4 Future Prospects for Rubbing Brick Producers

Modern rubbing-brick manufacture has over-concentrated on producing the fully-washed, late Victorian type of homogenous bodied brick. This has been at the expense of handpicked rubbers selected out of a general firing, creating unique tones and textures that were important in creating the cut, rubbed, and gauged work of previous centuries. The tendency to fire rubbers at higher temperatures is also of concern, not only for the loss of any pozzolanic benefit that diminishes markedly beyond 900-950°C, but also for those wishing to continue executing traditional hand crafting skills on soft rubbing bricks.

The move by some brick companies towards using mechanically cut and/or abraded rubbers for on-site assembly has led to the production of a harder brick. This enables it to withstand the spinning force of a cutting disc or profiled carborundum wheel, whereas a soft rubber would lose its all-important sharp arrises with the high-speed air vortex created by and ahead of the cutting or abrading heads. From an economic point of view, the softer rubber, ironically, causes excessive wear on these tools.

Several other brick or building product companies, such as Sussex Brick Limited, Kevington Brick Cutting, and Manchester Brick and Precast, advertise the supply of machine-cut gauged arches for on-site assembly or as gauged-faced lintels. These are either a brick of their own or one from another supplier; some of which have a tenuous claim to being an authentic rubber.

Almost all designers today use computer-aided design (CAD) programs rather than the time-tested geometrical methods of setting out and establishing working templets for arches practised by experienced craftsmen. This can and does lead to on-site assembly problems. Although CAD can be used to produce full-size drawings for templets or

setting out, careful checking for accuracy should be undertaken before use and in consultation with the designer. Gauged work demands accurate drawings from which all necessary information can be obtained by the cutter and setter. It is unforgiving of error and any deviation, especially when working to finer traditional tolerances, as these become exaggerated if the setter tries to build-out the mistake.

Bricklayers can find that pre-assembled units do not fit precisely together, once laying commences, and rub-up individual bricks to resolve the problem. This should never be done as, after due consideration, one might discover the error was not with that particular brick; one is therefore only compounding this error. This practice also removes the responsibility of the supplier to ensure an accurate fit, as one has interfered with the original setting out and cutting. Faced with such a problem, if all is correct with the intended enrichment, first recourse must be with the supplier.

Clearly the production of purpose-made or precast arches and machine-cut gauged architectural enrichments, economically satisfies a modern demand for on-site fixing of quality-controlled units and removes the need for a cutting shed and the highly-skilled labour necessary to prepare, set-out, and cut the rubbers. These, however, only serve to exacerbate the loss of traditional craft skills and associated knowledge necessary to set-out and work the rubbers. Furthermore, precast, gauged-faced lintels have little, if any place on historic buildings. Peter Hill in discussing this in respect of traditional stone and gauged work says:

In the face of masonry by extrusion, which is economically cost effective, allow the use of dead, lifeless, machined stone, or brick in historic buildings, a trend, which will be difficult to reverse....(Hill, 2004)

The ultimate manifestation of this development of precast gauged-faced work is the entire ashlar facade of the new city of London Headquarters for international finance company Merrill Lynch, in Newgate Street (Hammett, 2000, 30-31).

Most, if not all, who cut ready-to-assemble or pre-assembled units are not time-served bricklayers with site experience of gauged work. Bricklayers who have been taught how to set-out, cut and set gauged work will always produce a high standard when building purpose-cut work as they fully understand how to set everything correctly. Historically, 'hewers' and 'cutters' have always been the best craftsmen bricklayers experienced, in setting their own and fellow craftsmen's cut work, vital, as their bench-cutting empathised with the bricklayer setting it.

Mechanised cut curved profiles are sometimes found wanting. For example, on an arch elevation where there is to be a moulded label, both the moulding lines and the extradossal and intradosal surfaces tend to be tangential rather than radial. There is also frequent conflict at the interfaces between face and return mouldings. Finally, some cut return mouldings are formed by a combination of cut and stick techniques (Figures 96 and 97). These are made all the worse by the use of hard impermeable epoxy resin adhesive which, despite the inclusion of brick dust to disguise the deceit, is visible and proves difficult to rub-up in finishing. These are a poor substitute for the original hand-cut originals they seek to copy and frustrate the bricklayers using them demanding unnecessary time in finishing, made all the more difficult because of the harder rubbers.

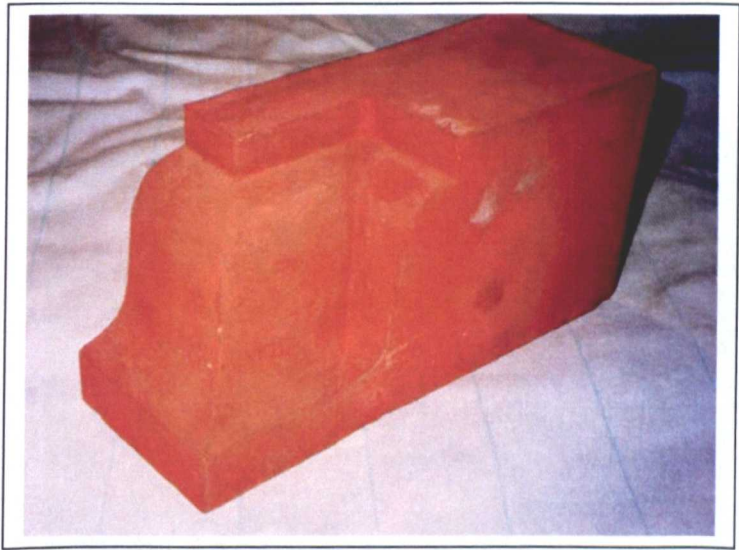


Figure 96 Cut and stick technique.

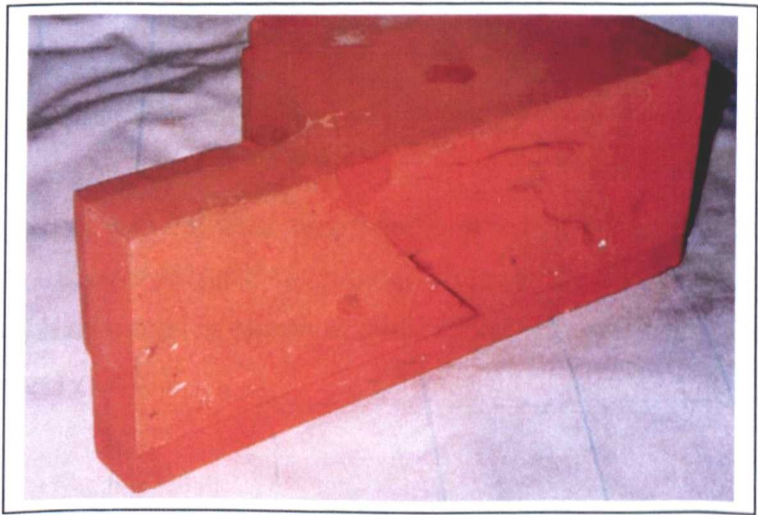


Figure 97 Cut and stick technique showing the reverse side.

Modern purpose-made units, for on-site assembly, are not always formed true to the style of the period, particularly gauged flat, or camber, arches that are often set out and bonded to a standard workshop format. Such practices are of particular concern, as the skills of the brickmaker are clearly not those of the qualified bricklayer with experience of working with historic gauged brickwork.

Furthermore, and especially in historic brickwork conservation or restoration, there is nearly always the need to hand-finish rubbers to match the unique facing techniques of the surrounding original work. Mechanised work looks what it is, devoid of a craftsman's touch, and can appear dead in its lack of tooling and abrading styles (Figure 98) or, as former Senior Lecturer in Brickwork at Willesdon College Of Technology, Bob Baldwin remarked 'It has no heart...' (Baldwin, 2004).



Figure 98 Hand cut egg and dart moulding by the author behind one that has been machine cut.

Combine these points with the aforementioned problem of differing texture when matching modern rubbers to historical originals (Figures 99 and 100), and one can appreciate how the character of charm of quality Stuart, Georgian, or Victorian brickwork can readily be lost.



Figure 99 Gauged flat arch in which the rubbers reveal their texture and small inclusions, at Wren's The Royal Observatory, Greenwich, London, 1675.

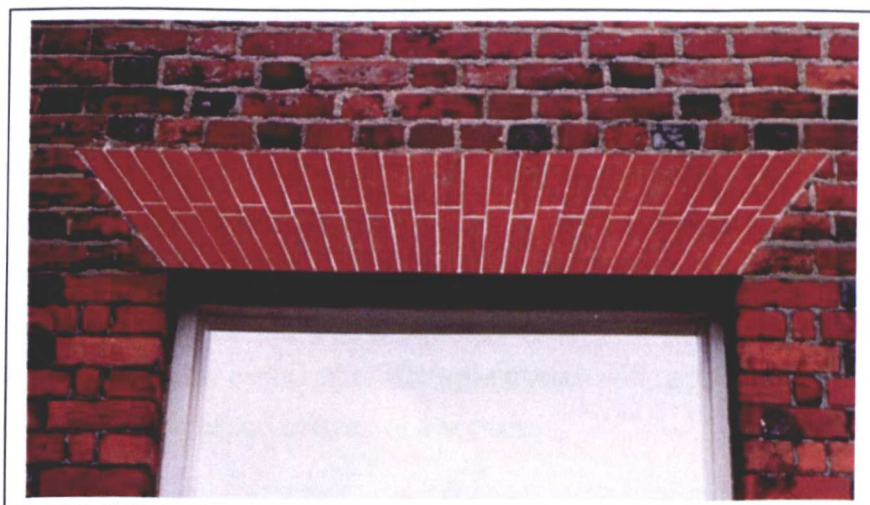


Figure 100 A replacement gauged arch at The Royal Observatory, Greenwich, London, 1675. This does not match the surrounding original work in colour or texture, and is set-out and built incorrectly.

It is entirely understandable that brick companies will seek to increase productivity and some companies will produce rubbers that are better suited to their own particular in-house cutting and moulding techniques. We must, however, retain a balance and not lose sight of the variety of soft-textured rubbing bricks that can be produced – albeit in a

small, even seasonal way – so that we have a product that is wholly appropriate for the repair and conservation of historic buildings.

2.6.5 Bricklayers – from Apprenticeships to Training Schemes

The 1914-18 war devastated the flower of time-served bricklayers, men the craft could ill-afford to lose and who would have passed on the high level of skills taught to them by their Victorian masters. The Operative Bricklayers Society (OBS) merged with other craft unions in 1921 to form the Amalgamated Union of Building Trade Workers (AUBTW), losing a national voice to represent high-level craft ideals. Many conscientious bricklayers became increasingly concerned for the future of the craft, with its heritage of skills, knowledge, and standards of excellence founded on a sound apprenticeship. This was particularly true of brickwork instructors responsible for theoretical education and refining practical skills of apprentices in new technology colleges opening in major towns and cities. From the inspiration of E. Lindsay Brayley, the Guild of Bricklayers was founded in 1932, with the aim of forming an association of journeymen and apprentice bricklayers, to disseminate information and skills, and raise standards of craftsmanship and the status of the craft in the eyes of the public. The Tylers and Bricklayers Company still promoted the craft of bricklaying within its historical London area.

The hierarchy of apprentice, journeyman, craftsman, and master craftsman, nevertheless, remained a fixed and powerful force within building companies. In the larger towns and cities, apprentices attended local technical colleges to gain additional theoretical and technical education and refine practical skills. This was seen as essential to achieve highly productive, accurate tradesmen capable of executing a wide range of skills within the broad canvas of the craft.

Only the finest apprentices were selected by the older experienced craftsmen to share in the knowledge and finer craft skills of the cutting-shed and learn gauged work. This judgement was based on the technical and practical competency and of the individual and all-important characteristics of enthusiasm and patience to learn and ultimately master the wide breadth of skills demanded. Although no statistics exist, it is likely that only the top 5% of bricklayers in each historic period were ever truly masters of gauged work, capable of advanced work such as setting out, cutting, and building a niche. Yet

probably around 50% of all qualified bricklayers would have possessed varying degrees of competence in the skill for work on basic arches and cut-moulded enrichments.

Study of the apprenticeship syllabus of college tuition to gain the Intermediate and Final City and Guilds examinations in the 1920s and 1930s reproduced in *The Modern Bricklayer* (Frost, 1931, 130-32), is most revealing. There is a specified emphasis and depth for sound education in theory, science, related technology, mathematics, geometry and workshop practice, which allowed the most capable apprentice to experience and develop their potential to excel at gauged work

Frost (1931, 83), making the distinction between axed and gauged works says that axed work may be '... considered as the first step or introduction to the highest grade of bricklaying: gauged work... for this class of construction exceptional skill is necessary in the craftsman...'

In discussing the opportunity to learn gauged work, Frost continues (1931,87):

...The young craftsman of the present-day has no doubt great opportunities for extending his knowledge in this particular section of his craft. In the old days cutters were looked upon in the trade as very superior beings compared with the general bricklayers...great strides have been made in technical education, and today there are unlimited opportunities for the young craftsman to obtain all the knowledge he requires....

Throughout this period, up to the Second World War, practical and theoretical examinations for the City and Guilds of London Institute intermediate certificate were held for both part-time day and evening class students. Below are questions relating directly from papers of the 1920s, re-produced by Frost (1931, 135-36) directly relating to gauged work:

BRICKWORK 2ND YEAR: THEORY AND DRAWING

(1) Give full definitions and neat sketches of the following terms: Skewback, Key- brick, Gauged-apron, String-course...

(5) What are the following tools used for: Cutting-saw, Pointing trowel, Three-foot level straight edge, Builders' square, Bevel, Square?

BRICKWORK 3RD YEAR: THEORY AND DRAWING

(2) Draw, to a scale of 1½in. = 1 ft., the plan and elevation of a semi-circular niche with 4½in. in thickness in gauged brickwork. Span 3ft. 0in.

BRICKWORK 4TH YEAR: THEORY AND DRAWING

(1) Draw to a scale of 1in. to 1ft., about two-thirds of the elevation of a gauged camber or Georgian arch, span 4ft., face 9in., soffit 4½in. On this drawing indicate the method of obtaining the cutting marks or the templates for the "Springer" and "key" bricks or voussoirs.

2.6.6 1945 to Present

Following the Second World War the apprenticeship period and City and Guild syllabi remained essentially the same as the pre-war format. As the 1950s settled in and extra government money became increasingly available, more further education colleges began to offer academic and practical study. Generous local authority grants enabled students to access the city and town colleges from the outlying rural areas. Far-sighted government funding allowed craft workshops to be well equipped with a variety of up to date and good-quality materials, tools, equipment and machinery. Qualified and experienced lecturers were able to provide the necessary, depth to fulfil the needs of both the syllabus and local builders. This was indeed a 'Golden Age'.

Working as a senior lecturer at the Northern Polytechnic of London, Hodge acknowledges the fall from fashion of gauged work, yet emphasises its importance to be learnt for a full rounded craftsman (1944, 164):

Unfortunately the demand for gauged brickwork has declined during the past three or four decades; nevertheless it is part of the bricklayers' craft and the apprentice should be prepared to carry out such work for the architect who may wish to find a place for it in a modern building...it gives a thrill such as only the true real craftsmen know.

Lindsay-Brayley, then Head of Junior Building School in Bournemouth (Dorset), was less optimistic. Yet he acknowledged its worth in developing future craftsmen (Lindsay-Brayley, 1945, 66):

Gauged Work. Heavy patterning and moulding are now obsolete, and also, in a less degree, is gauged and rubbed brickwork; the only places where they are still carried on are the workshops of technical schools....

...There are still craftsmen who specialise in gauged work, which consists of baptismal fonts, niches, vases, and other ornamental details, this work being beyond the scope of the general craftsman.

Study of the City and Guilds syllabus 'Brickwork 82, 1966-67' for a five year apprenticeship, reveals that gauged brickwork was introduced through theory, geometry, and drawing in the second year and at a practical level in the third year of the 'Intermediate Craft' stage. During the fourth and fifth years, for the more capable apprentices in the 'Advanced Craft' course, the content covered gauged plinth and

string courses; mullioned, transomed and traceried windows; niches; and a variety of arches for construction in the college workshop.

The majority of building firms trading in the 1960s used a directly employed workforce. Most had yards in which they stored materials and plant, and had workshops assigned to particular crafts. Under such conditions, where a firm obtained the quality of work, the skills required for setting out, cutting, and setting gauged work could be employed and taught, and support of the traditional apprenticeship system given. Building booms of the late 1960s and 1970s attracted many bricklayers from old established building firms to sub-contracting, concentrating solely on their craft needs and departing as quickly as possible to maximise earnings. These were, and remain, an inward-looking workforce with no eye, or indeed interest, for either the past or the future; a view upheld by older and wiser craftsmen who predicted its disastrous effects on the crafts, but were powerless to restrain it.

The end of the 1960s reduced the indentured apprenticeship leading to certification by City and Guilds to four years, three years to achieve a basic Craft Certificate and a fourth year for the Advanced Craft Certificate. This was quickly reduced to three years - two years for Basic Craft, and one year for Advanced Craft - and consolidated by the *City and Guilds 588 - Brickwork and Masonry* syllabus (City and Guilds, 1976).

Study of this syllabus, detailed in a comprehensive 60-page booklet, reveals an emphasis on a holistic approach to the craft, in order to provide sound theoretical and technological education supplementing a wide range of practical skill elements. Although greatly reduced in comparison with earlier syllabi, gauged brickwork was retained. It was not, however, always expressly described as such within an overall topic area. For example, in Brickwork 'Craft Theory' the syllabus required knowledge of:

Setting out, temporary support and construction of cambered, segmental and semi-circular arches, straight on plan up to 3m span.

In the 'Associated Subjects', the requirement was for the student to learn:

Geometry of the circle, segment, sector, chords and tangents. Applications to setting out arch forms and curved work.

This was consolidated by the stated 'Practical Activities' for the student to practise:

Setting out, cutting and building camber, segmental and semi-circular arches.

W.G. Nash Head of the Department of Construction at Southampton Technical College, describes setting out, cutting, and constructing gauged niches and arches circular on plan and elevation in his work published in 1966. This is a craft area termed 'circle-on-circle' work that was not retained within the syllabus of the three-year City and Guilds apprenticeship.

In 1979 H. Bailey and D.W. Hancock, Senior Lecturers at Stockport College of Technology in Lancashire, published on the perceived needs of the three-year apprenticeship, but significantly there was minimal reference to gauged work, being restricted to camber arch construction alone (Bailey and Hancock, 1979, 60-61):

...known as camber or Georgian arches. These are constructed of bricks known as rubbers, which are soft enough to be cut with a bow saw and rubbed on a stone to the exact shape required.

The simplistic explanation of how to set-out and cut a gauged camber arch reveals the resigned attitude towards this branch of the craft. (Bailey and Hancock, 1979, 67):

The traditional method is much more complicated and is considered beyond the scope of craft certificate students, as is the building of this arch.

At Bedford College of Higher Education during the 1980s, as Head of Trowel Trades the author set about broadening the curricula for the second and third-year apprentices. This move was intended to allow apprentices to gain a more holistic understanding of their chosen craft, by re-introducing long-lapsed branches of the craft and a range of traditional skills and associated knowledge, without compromising the *City and Guilds 588 - Brickwork and Masonry* syllabus or their modern site needs.

This syllabus was, it is considered, interpreted nationally and within publications to support delivery, solely as a preparation for apprentices working with modern cement: sand mortars and cavity-wall construction. Also, despite clear references to various traditional materials and skills within the syllabus, (this justifying their re-introduction), there was no historical content or context to them. This was deemed a serious omission, as apprentices would fail to understand why a certain skill was developed or recognise when and how to apply it today. Much of what was available concerning

traditional aspects of the craft was narrow on interpretation of historical practices, and served only to mislead and confuse.

Five main factors enabled the history, knowledge, and craft skills of gauged brickwork to be pioneered at Bedford College:

1. The in-built flexibility of the *City and Guilds 588 - Brickwork and Masonry* syllabus allowing delivery of its implicit overall objectives for apprentices, yet permitting development and nurturing of the naturally talented students by a more advanced interpretation and level of a subject to extend personal ability.
2. Recognising the un-tapped natural academic ability of many craft apprentices who, for various reasons, had not pursued O and A-level examinations. Most were capable of being enthusiastically stimulated and thus receptive to the more challenging educational and skill areas of study. All true craftsmen and women possess high intelligence.
3. Recognising that most apprentices were not working for large building companies that required bricklayers proficient only in basic skills of laying bricks and blocks to line, level, and plumb. The majority worked for small building firms on one-off new buildings, extensions and minor works, and, most importantly, on the repair, repoint, and restoration of traditionally-constructed buildings. This required a whole area of craft knowledge and skills simply not catered for at a national level.
4. The positive support from the building companies and bricklayers who could see the benefits of having a more fully-rounded apprentice capable of undertaking a wider range of practical work. Also, in how they could see that, as the apprentice began to learn the skills of precise gauged work, the quality of the standard brickwork improved dramatically.
5. The knowledge, skill, experience, and enthusiasm of the author, who had for some years previously been writing about gauged work as the highest expression of his craft. (See Lynch, 1990)

The period of 1987-92 at Bedford College saw a huge rise in national awareness for and interest in gauged work, and what the craft apprentices in the workshop were achieving there at very high standards. This in turn, helped to stimulate craftsmen and also brickmakers, surveyors, designers, and those charged with caring for the nations

historic built environment (Figures 101 and 102). Brick and lime producers as well as national professional and amenity societies provided support for this initiative.



Figure 101 General view of a gauged work project undertaken at Bedford College by the craft and advanced craft apprentices between 1988 and 1991.



Figure 102 Close-up of some of the gauged enrichments executed by craft apprentices at Bedford College between 1988 and 1991.

Sadly, the lofty ideals of establishing Bedford College as a centre of craft excellence for traditional skills coincided with a national policy on craft training that moved in direct

opposition. Writing in 1993, after leaving the college, Lynch (1994, 66-68) urged caution:

A significant development in the delivery of training has been the introduction of the National Vocational Qualification (NVQ) system, designed to rationalise qualifications throughout industry, and to guarantee the competence of trainees by demonstrating that they satisfy specified performance standards.

The important consideration now is not how long it took to achieve, at what age, or where the skills were acquired. In effect, there is no set length of apprenticeship; to become qualified, it is only necessary to demonstrate job competence in the required units of construction.

If learning craft skills had not required five or three-year apprenticeships, then those with past responsibility for the crafts would not have provided them. Time-served apprenticeships were all about a combination of growing maturity and in-depth learning to gain overall experience and competence.

By the early 1990s, acceptance of a dramatic national decline in the knowledge and skills of gauged work was revealed in the revised fourth edition of J.C. Hodge's *Brickwork for Apprentices*, where the original chapter on gauged work was omitted. The understandable reasons were given (Hodge and Baldwin, 1993, 133):

Much thought was given before deciding to omit this chapter (which fully described this highly skilled aspect of the bricklayer's work) from this revised edition. The primary reason for leaving it out is that these red rubber bricks are no longer available; another reason is that modern methods of cutting voussoirs on masonry bench saws have displaced the labour-intensive traditional method of cutting and rubbing by hand.

In 1994, the Conference on Training in Architectural Conservation (COTAC), working with the City and Guilds and CITB, convened a working group to develop an advanced NVQ at a higher level than that offered within the basic craft modules. This would lead to a Master Craft Diploma. Leading figures from each building craft, including the author, were invited to assist in developing this important objective, seeking to define the range of skills necessary for conservation, restoration, or refurbishment within each craft. This included gauged work within bricklaying.

This initiative had some degree of success, but struggled with inadequate funding, limited colleges capable of delivering it and (within the craft of brickwork) a lack of practical lecturer experience to teach with authority and confidence. It was also, it is felt, an error to choose to use the term 'Master' within this additional qualification, implying that upon successful completion of the course one would become a master craftsman. Such a move would have granted every bricklayer who served a traditional five-year

apprenticeship the automatic status of master bricklayer when in fact they were only journeymen.

At this time the author was approached by Mr Richard Harris of The Weald and Downland Open Air Museum (West Sussex) (who had previously visited Bedford college to view the work that had been undertaken there) to develop and present introductory courses and master classes in gauged brickwork at the museum site. This has proved very successful down through the years, and has led to the introduction of an advanced class in which arch construction is examined, and several of the more able students have further developed their skills and knowledge through personal tuition at the author's workshop. Other organisations have subsequently made efforts to introduce the basics of gauged brickwork to a wider audience, such as, Essex County Council in conjunction with Bulmer Brick and Tile Company Limited.

In recent years national political attention has picked up on problems of recruitment within the craft of bricklaying. According to the *Construction Skills Foresight Report 2003* (CITB and CIC, 2003), the average annual requirement for bricklayers is 5,300. Trainee numbers for construction courses, further education colleges and training centres show that there are 5,029 for the under 18 age group, with a further 3,370 from the over 18 age group. It is indicated that of the combined group there will be a 40% drop out rate, equal to (3,360 trainees), leaving a total of 5,039 trainees who go on to complete their courses.

These figures relate to the provision of tradesmen and women with basic craft skills for modern site demands. They ignore the more acute shortage of high-level skills, such as gauged work, within the craft, necessary for executing the more complex works and especially of those caring for our huge stock of historic, traditionally-constructed buildings (Figure 103).



Figure 103 Modern replacement gauged work executed at Warfield House (Berkshire), c. 1740.

Some issues in respect of this have been highlighted in various publications from government bodies and relevant heritage groups. Among the most significant are *Planning Policy Guidance 15: Planning and the Historic Environment* (DoE DNH, 1994), *Power of Place : The Future of the Historic Environment* (English Heritage, 2000), *The Historic Environment : A Face for Our Future* (DCMS, 2001), *Sustaining our Living Heritage: Skills and Training for the Heritage Sector* (HLF, 2003), and, with specific regard for maintenance issues, *Maintenance Education and Training for Listed Buildings* (Watt and Colston, 2003).

The problem of the acute shortage of high level skills and its possible solutions, embraces social, economic, academic, and philosophical issues, as well as the more obvious craft concerns. Drawing on a range of comments from invited craft and professional representatives, it is possible to summarise key issues:

Loss of Time-Served Apprenticeships

Traditional time-served apprenticeships ensured that wide-ranging skills and knowledge were obtained alongside practical experience. Skills can only be learnt by practising them full time surrounded by people who are far more proficient, the seven-year apprenticeship may have been too long, but the three-year apprenticeship was too short. Today (2004) we see a growing loss of time-served experienced craftsmen, and it is only by experience that skills are truly developed. This loss will manifest itself in the future as the lack of current investment in high-level craft skill and knowledge, becomes apparent.

Craft Training

Intelligent young people are encouraged to attend university courses and not craft training as it is seen to be of less value. Careers advisors and local employment offices because they perceive brickwork as the least skilful and technically demanding of all crafts are inappropriately channelling students with modest ability, and after minimal assessment, into craft training. These students often have little personal motivation to embark on this route and are often disruptive.

The College Position

Pressure is put on college staff to achieve very high pass rates at NVQ levels. Paperwork and not practical experience drive the overall quality of NVQs. Low attainment rates are due to financial emphasis on colleges to fill course places at any cost, rather than enrolling suitably selected students with a common goal.

Insufficient time is allocated to students to fully achieve and develop as competent tradesmen ready for site work. This is not helped by the fact that many of the craft students who attend college unfortunately lack the key skills to proceed through the craft training programmes without difficulty. While these issues are addressed ground is lost in the practical and technical lessons.

The Industry Position

There is a lack of financial and practical commitment by way of on-the-job training in the industry, by small, medium and large contractors. This is primarily due to the use of sub-contracted labour working transiently on modular building work (rather than directly employed personnel) as a way of keeping cost to a minimum. Large housing contractors dictate to modern training programmes to solely meet their needs.

Recommendations

- Introduce accountable, time-served apprenticeships that are respected by the industry.
- Appoint an independent governing body to oversee the apprenticeship scheme to ensure fulfilment of contractual obligations and not as a method of ready supply of cheap labour.

- Raise the academic and practical content of education for craftsmen with a qualification akin to a university degree.
- Introduce a list of 'Masters' considered to be of exceptional value to the Nation, and establish funding to enable them to pass on their knowledge and skills.
- The construction industry should be re-positioned to ensure employment of suitably qualified craftsmen and to raise the overall status of the crafts.
- Incentives offered to employers to re-establish direct employment for apprentices, in order to provision on-the-job craft training.
- Provide financial assistance for students who have the aptitude and dedication to learn, so that they can study with a master craftsman.

2.6.7 Future Prospects for Gauged Brickwork Training

For gauged work to be successfully taught there are several issues. Namely, that the person tasked with delivering it must have a firm grasp of the subject, historically, technically and practically and is working out of a fully equipped workshop or training centre. It would be important that the student, at any stage in their career, is assessed to ensure they have dedication, academic and practical ability to succeed. Course design would need to follow in a logical sequence of academic and practical tuition, to develop the contextual knowledge and skills necessary to ensure full understanding and balanced development. This course would require approval by the relevant examination and heritage bodies who cover, or who have an interest in quality craft training, leading to assessment with carefully determined high level standards, resulting in qualification. It would be important to break down the traditional skills of gauged work into their individual basic elements at the introductory stage, such as squaring up for ashlar and straight moulded work. This would encompass:

- Identification and selection of the rubbing bricks
- Identification, preparation, use and care of the necessary tools
- Preparation of the brick ready for cutting
- Studying drawings, related geometry, and obtaining templets
- Cutting the brick by use of brick axe and scotch as well as the bow-saw methods
- Testing the cut brick for accuracy
- Identification and selection for materials for setting gauged work
- Preparation of bricks and materials for setting gauged work
- Setting out methods for construction of basic gauged brick elements

- Construction of gauged brickwork
- Finishing of the built gauged brickwork

This would run side by side with the delivery of the historical background of cut and rubbed and gauged brickwork, alongside the essential related theoretical and technological aspects of the subject to underpin, the above practical elements.

Upon successful completion of this introductory stage, if important to their sphere of work or overall interest in the subject, the student could proceed to more advanced levels. This would need to be a planned logical progression of skills and their underpinning knowledge that deal with the more complex features of gauged brickwork. This would allow the student to also learn advanced masonry skills with associated tool use, in order that they can undertake hand work on enrichments such as return mouldings, and internal radius work. The breadth of the advanced work cut and rubbed, and gauged work would incorporate:

- | | |
|--------------------------------|----------------------------------|
| • Cut moulded architraves | • Mouldings |
| • Pilasters, Columns and piers | • Cornices |
| • Pediments | • Circular work plain or moulded |
| • Tracery | • Double curvature work - niches |
| • Vaults | • Carving |

At this level it would seem more prudent and cost effective to operate these highly specialised courses with limited demand within the fully equipped workshop of an acknowledged master, who would have all that is required to deliver it, and meeting the standards of approval of the relevant certifying bodies.

Having developed in aspects of the above cut and rubbed, and gauged brickwork, the student could be introduced, to the knowledge and skills necessary for the successful repair and restoration of gauged brickwork. This would also have to incorporate tuition not only in the causes of failure and decay of cut and rubbed, and gauged work, but also on philosophy of repair, correct planning, and approved remedial measures that are integral parts of such work, particularly on listed properties.

An overview of some practical elements, which would be taught with associated theory and technology, can be defined as:

- **Replacement of ashlar work**
Cutting out and replacing individual bricks
Plastic repairs
Colour/texture matching
- **Replacement of mouldings**
Obtaining templet/s to replicate original profiles
- **Repairs to arches and niches**
Removal, preparing and relaying of individual voussoirs/bricks
Dismantling and re-building complete arches
- **Re-pointing**
Preparation of joint to appropriate depth
Preparation of joint prior to re-pointing
Selection of materials and preparation and mortar
Selection of tools to execute re-pointing
Application of pointing (modified form of tuck pointing)
Preparation of test panel to assess joint finish
- **Curing and protection** (sun, wind, and inclement weather)
Provision of proper curing and protection
Identification of suitable working periods (minimum temperatures)

In most respects we are no less able today than the bricklayers of previous centuries who produced masterpieces of gauged work. What is rapidly being lost is the wide range of essential crafting skills, with instead, an over-emphasis on limited theory and practice to acquiring simple fixing skills, demanded by a hugely influential modern construction industry. One ignores a craft's history and traditional skills at one's peril.

If a man dwells on the past then he robs the present. But if a man ignores the past he may rob the future. The seeds of our destiny are nurtured by the roots of the past [Chinese proverb, s.l.].

Gauged brickwork was, and remains, the highest expression of the bricklayer's craft, for so long overlooked within studies of the nation's historic architecture. The knowledge, skill, and ingenuity displayed in the bricklayer's articulation of cut, rubbed, and gauged

enrichments have, for many centuries, played a crucial part in our brick-built heritage. It is part of a significant national resource of which we should all be proud, and safeguard for future generations.

Summary

The period from 1918 to the present (2004) has witnessed the move away from enriched mass-masonry laid in lime-based mortars to calculated, thin-walled, structural envelopes, set in cement mortars to meet the required speed of erection. This has witnessed building crafts changing from crafting to fixing skills, leading to some brickmakers producing a harder rubber that responds favourably to mechanised cutting and shaping in order to supply pre-cut enrichments for on-site assembly. This is reflected in the demise of the traditional time-served apprenticeships to short modular training courses, supplying tradesmen for modern building sites. This has resulted in a severe shortage of highly skilled and knowledgeable craftsmen who can confidently undertake cut and rubbed, and gauged work. Such a change impacts on the quality of work vital for the successful repair, conservation, and restoration of historic brick properties, and for its positive inclusion on new buildings erected for the discerning client. Due to these factors, it is increasingly common to employ stonemasons to carry out the repair and restoration of gauged work because of the continued emphasis on the fine crafting skills in masonry that are common to both. So, in many respects, the story of cut and rubbed and gauged work in terms of the ongoing development turned full circle within the two allied masonry crafts.

3.0 THE DESIGN AND EXECUTION OF A GAUGED NICHE MASTERPIECE.

3.1 Introduction

The construction of a gauged niche has always been considered the supreme test of a bricklayer's skill as a craftsman, for it requires sound knowledge of geometry as well as excellence in all-round manual dexterity. Without both, it would be impossible to set-out, prepare, and construct such a complex element. Indeed, in parts of the Netherlands during the sixteenth and seventeenth centuries, a gauged brick niche was one of the few selected scaled models constructed by the top apprentices as their 'Gildeproeven' or masterpiece for their guild masters; these can still be seen today in De Waag, Amsterdam.

Gwilt (1888, 922) defined a niche as:

...a recess constructed in the thickness of a wall for the reception of different objects, such as statues more especially, but occasionally also for that of busts, vases and tripods. Vitruvius makes no mention of niches, and but for an inscription published by Visconti in the 'Monumenti Gabini' we should not have known that they were by the ancients called 'Zothecoe' or places for the reception of a figure. Our English word niche is evidently derived from the Italian 'Nicchio', a shell.

A niche is usually semi-circular or semi-elliptical on plan and covered with a semi-dome of the same character. The lower part is termed the 'body' and the upper part the 'hood'.

Niches of fine gauged brickwork appear in England in the late seventeenth century and are undoubtedly inspired by those in the Netherlands, the bricklayers of which had earlier perfected the rules of their execution. Fine examples are to be seen at Hampton Court Palace (c.1690), Bradmore House (c.1700) (re-erected in the Geffrye Museum, London), Eltham orangery (c.1717), and at Finchcocks in Goudhurst (Kent) (c.1725), all worthy of study.

It was decided as part of his doctoral research programme that the author should set-out, prepare, and construct a scaled gauged niche in the manner of a gildeproeven. This was undertaken to demonstrate excellence in the attributes outlined above, as well as help explore and gain a deeper knowledge and experience in the historic crafting

aspects of this highly skilled branch of brickwork. The rubbing bricks selected for this work were original oversized TLB orange bricks (produced in the 1950s) from the author's personal collection. They were of a third grade in comparison to the premier Cherry Red rubber and also within that grade, of inferior second quality that were sold relatively cheaply to colleges to enable apprentices to learn the practical skills of gauged work within the limited budget available. The colours varied from a light orange through to a darker orange/brown, and also in individual quality and texture. The choice of such a brick was therefore ideal as this practical aspect of the research was to be completed using only traditional materials. It is considered, within the craft, that it is relatively easy to produce quality work with good materials, but it is the mark of a true craftsman to create it from inferior products.

3.2 Design

Work began on the niche in September 2002 with a design that has a semi-circular body and hood, the latter with radiating voussoirs terminated on a slightly projecting boss, carved with scalloped flutings in the traditional manner. The construction is in English bond.

This choice of design was constrained by several factors relating to the limited number of original TLBs available - about 25 in number from which to cut the many scaled-down niche bricks. The individual bricks ranged in size from 245 x 115 x 80 mm to 260 x 130 x 80 mm.

It was decided that, working on a cut brick gauge of 27 mm, six or possibly seven smaller bricks could be carefully cut from one rubber. By adopting an ashlar unit of 102 x 50 x 27 mm on an opening/diameter of 315 mm this would give one cut course for the body and two courses for the hood, from one over-sized rubbing brick.

The niche was first drawn to its basic shape, in outline only, to full scale to determine overall dimensions and a joint size of 1 mm to be in proportion with the cut bricks. Once complete, the information was given to Simon Douch, conservation architect, to produce a full set of CAD drawings (elevation, section, and plans of courses one and two) (Figure 104). Simon Douch had worked with the author on the restoration of the Bradmore niche, now at the Geffrye Museum, and had expressed a keen interest in learning more about the technical and practical aspects of niche construction. It was

also an opportunity to explore and assess how the use of CAD could be employed for setting out gauged work. The author would normally set out an entire niche using traditional geometry, as indeed he did later on the project whilst teaching Emma Simpson. It was therefore agreed that Simon Douch would produce the CAD drawings in return for personal tuition.

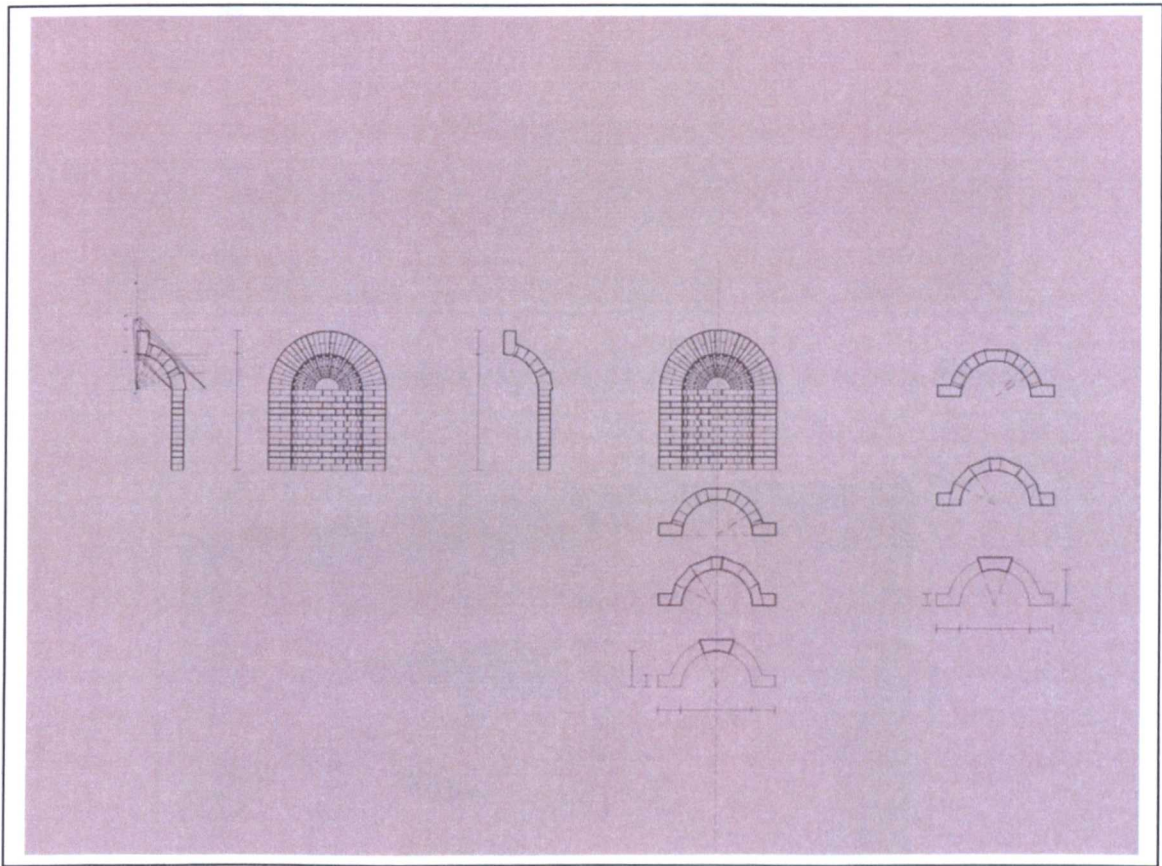


Figure 104 CAD drawing of gauged niche masterpiece by architect Mr Simon Douch.

3.3 The Templets

CAD-based plans, detailing the alternating stretcher and header courses allowed for various cardboard templets to be prepared for the necessary five individual cutting boxes to be accurately made (Figures 105 and 106).



Figure 105 Templets necessary for cutting the body and the hood of the niche.

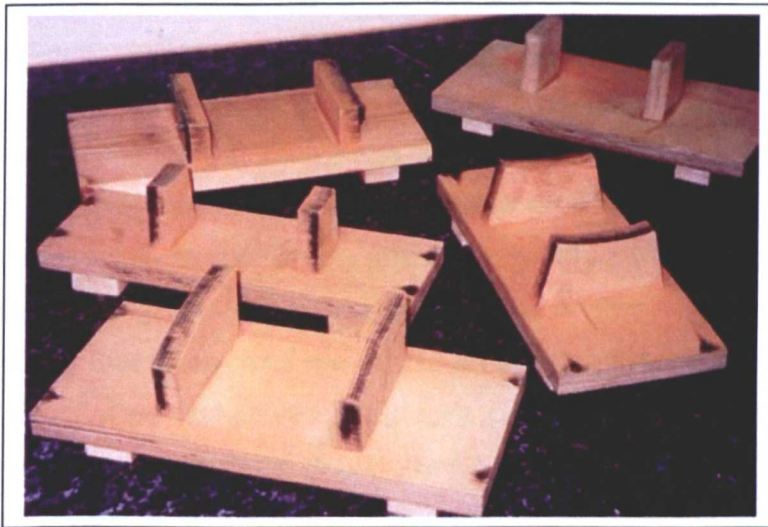


Figure 106 Cutting boxes for the niche body.

The drawn section was used to establish the three templets essential for the timber radiating box to establish the hood voussoirs. A combination of details from the plans, sections, and elevations provided the three templets required for creating the hood mould over which the voussoirs are turned. Finally, the six templets that were necessary to set out, cut, and check the boss on to which the hood voussoirs rest were prepared (Figure 107).

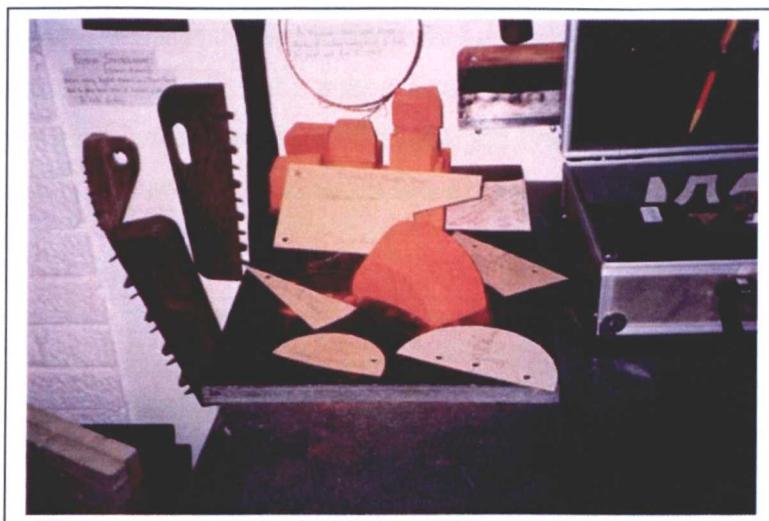


Figure 107 Templets necessary to create niche boss.

Derren D'Archambaud, a highly respected contractor dealing with the repair and restoration of historic brickwork, made all the cutting boxes for the ashlar, curved body and radiating hood courses, as well as the hood mould.

The importance of accuracy in each stage of the initial design cannot be over-stated. The drawings, templets, and cutting boxes must all be exact in every respect, as gauged work, especially to such a very fine scale, is unforgiving of error.

Communication of all details and factors that impinge on the construction of the niche is absolutely vital so that all involved are, to use an appropriate phrase, 'singing from the same hymn sheet'. This also serves to highlight why such high-quality bespoke gauged work is difficult to undertake in the modern construction industry. Traditionally, from the bricklayer's workshop drawings, the joiner's shop would undertake the making of the cutting boxes and the plasterer's shop the hood mould without any difficulty. Today, few such inter-disciplinary building firms with associated craft workshops or the craftsmen with the breadth of knowledge and skills to undertake these tasks remain.

3.4 Cutting the Niche

Work began on cutting the niche in early November 2002 and continued on and off, as time allowed, in the author's workshop. Health and safety is always of paramount importance with gauged work and particularly so in the rubbing and cutting stages when hazardous dust, high in silica, is generated. A special dust mask with dual replaceable filters was used at each and every stage of rubbing and cutting. All residual brick dust

was carefully removed by a vacuum cleaner from the rubbing stone, cutting boxes, cutting bench, and cut or abraded bricks before proceeding to the next operation. At the end of each working session the workshop was fully cleaned and all tools, equipment, and materials carefully replaced or stacked away ready for use. All off-cuts were placed into a waste box for removal. Disposal of all bagged brick dust and off-cuts was to selected craftsmen and women who came to work or attend courses in the workshop, (Figure 108).



Figure 108 Waste bricks and dust from cutting process.

3.5 Preparation of the Rubbing Bricks

The following stages were established at an early point in the preparation of the niche.

The oversized rubber was squared by abrading on the rubbing stone so that the bed, stretcher, and header faces were all at 90° to one another and the resultant cuts to the prepared rubbers were properly aligned and level for accurate setting.

The six or seven equal divisions - approximately 34 mm apart were measured along the length of the squared rubber, which were then scribed around the brick using a try square (Figure 109).



Figure 109 Oversized rubbing brick squared and scribed for cutting in to individual small scale bricks.

The brick was then placed in a large cutting box and each scribed section allowed to project, supported on folding-wedges, and then cut accurately to size and filed flush to finish. At this early cutting stage it became apparent that the quality of the bricks were going to present some difficulty in holding a very sharp arris, vital in finely jointed gauged work. This was because of a wide variation in the quality of the individual rubbers, which ranged from close textured, clean bodied that facilitated such fine cutting and rubbing, that worked well, to an open textured, sandy/gritty body with inclusions and internal voids, that were the direct opposite.

Once a whole selection of slices had been cut from several rubbers, each one was then treated as a brick for the remainder of the process. Each slice being first rubbed square on bed and face in preparation for cutting to the relevant moulded shapes for the body of the niche.

3.6 Cutting the Body Bricks

Both the stretcher and header courses had three different cutting boxes each, all requiring the bricks to be set-out and cut differently. Some utilised the bow-saw technique and others the grub saw. Once brought to shape, the bricks were cleaned and filed smooth along the cut surface. Sufficient bricks were prepared of each shape to construct four courses.

To complete the preparation of the cut-moulded bricks, they were then placed in the gauging box, scribed, and carefully cut and abraded down to the desired brick gauge for the niche of 27 mm. It was apparent at this stage that some of the poorer quality bricks were displaying slightly serrated arrisses, known as 'ragging', due to their nature as described above. This was to remain the pattern throughout all cutting and rubbing stages.

All the prepared bricks were then dry-bonded around the bay mould. This was of hardboard, set out to the width and radius of the opening that controlled the curve of the body of the niche. This was done to both check the overall accuracy of the bricks and as a means of keeping the vulnerable cut work in a secure manner (Figure 110).

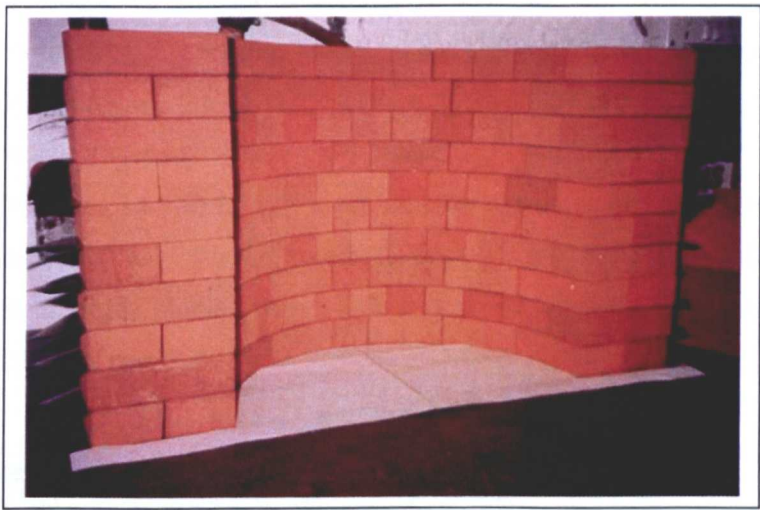


Figure 110 Dry bonding of the body of the niche.

3.7 Cutting the Hood

As the hood courses follow exactly the bonding arrangement for the body of the niche, the bricks had first to be prepared as if for the latter, as detailed above, before being cut in to the voussoir shapes necessary for the hood. This was executed within the radiating box, formed to follow exactly the templets obtained from the sectional drawing, so that each complete course, terminating at the boss, could be cut in one operation.

The squared bricks, having first been cut to the curve of the body, were brought to the correct bevel in order that the resultant cut voussoirs set at 90° to the arc of the hood arch and were not handed - to the left or the right, or off-centre. This was achieved by placing the stock of the sliding bevel on the intrados of the elevational drawing of the

arch face, and the blade of the bevel against the line of a bed joint, and the position of the latter then secured. This craft action is termed 'bevelling the brick from the soffit'. On a semi-circular arch/hood - as opposed to an ellipse - this remains the same for each voussoir.

This bevel was then transferred to the cut-moulded bricks by placing the stock against the soffit face and the blade to the radial bed face. A scribe then incised a line on that side, which was squared around the brick. The brick was then carefully rubbed down to this line on the rubbing stone, and the brick was repeatedly checked against the sliding bevel until correct. Once this was completed to all the left and right-hand bricks, either side of the central key brick, they were then ready to be placed one course at a time in to the radiating box, and cut in one pass of the bow saw. The problem of ragging of arrisses became particularly acute, especially on the thinner voussoirs towards the boss. To finish, after cleaning, the voussoirs were dressed-off smooth with the file and/or timber batten, working with great care, away from the timber profile in to the heart of the brick (Figures 111 and 112). Each course was scribed to its relevant side of the arch and numbered to its individual position, i.e. L 1V and R1V, by scribing in to their beds and then carefully placing them, in laying order, either side of the key brick course on the bench until needed.

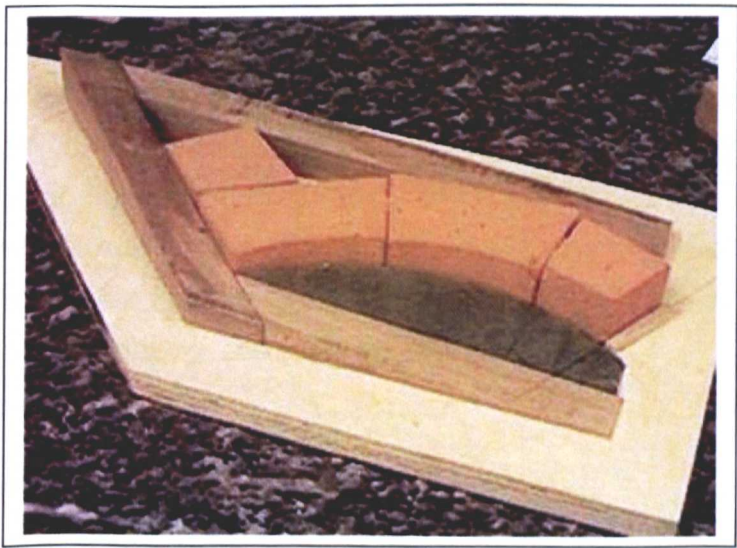


Figure 111 Bricks in reducing box for the hood before cutting and rubbing.

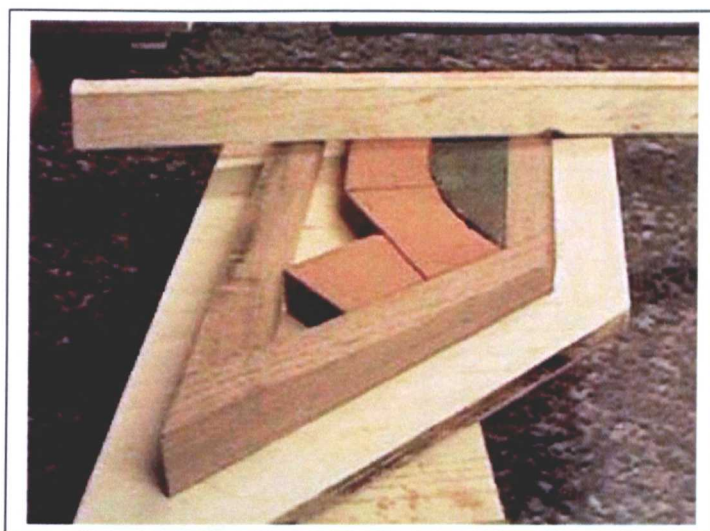


Figure 112 Bricks in the reducing box for the hood after cutting and rubbing

3.8 The Boss

It was impossible to cut the bricks to the wafer-like thinness at the extreme point of the hood centre, and was particularly so given the nature of these bricks. Therefore a 'Boss' is formed on to which all the hood voussoirs terminate. To form the boss a brick was set-out and hand cut to shape, as a miniature hood, to the same curve on plan and section, upon which all the voussoirs would abut. This was set out at one third of the hood radius and a traditional scalloped motif carved on to its face. Totals of six templets were obtained from the full-sized drawings to set out and check the boss during all stages of cutting for a precise fit. An original TLB Cherry Red rubber was selected for the boss, not only because it contrasted with the mainly orange rubbers used for the rest of the niche, but also the finer quality of the body of the brick being perfect for intricate hand cutting, shaping, and carving.

3.9 Cutting and Shaping the Boss

From the base templet the prepared rubbing brick was cut to the radiating shape on plan. Placing the front face and rear face templets in front and behind the brick working to the centre line (Figure 114), the outlines were scribed on to the brick and it was cut and abraded to the profile. Next the concave face was worked on the boss, and checked with the templet (Figure 115).

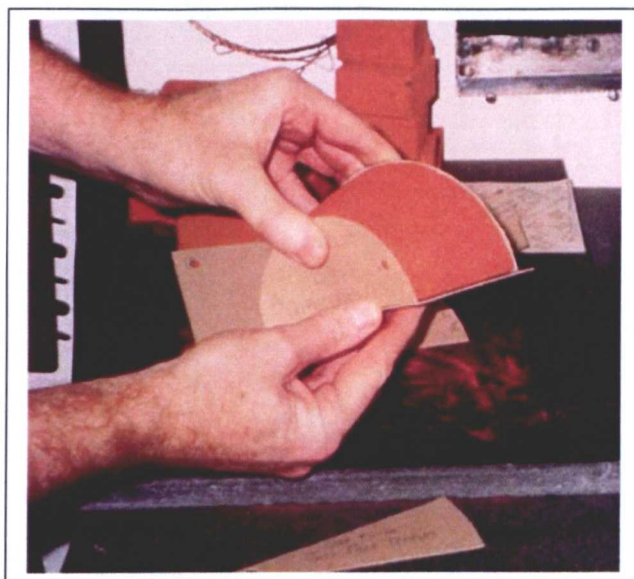


Figure 114 Checking front and rear face of boss and its plan on the appropriate templates.

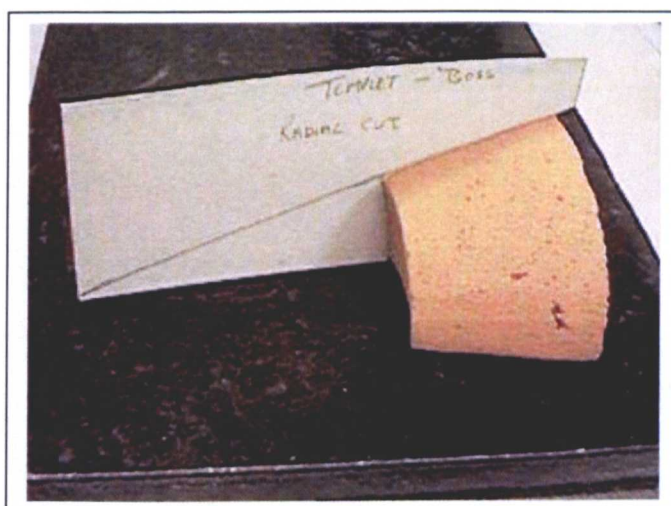


Figure 115 Checking concave Boss face and radial accuracy with templet.

3.10 Dry-Bonding the Niche

With all the cutting of the niche body and hood courses completed by the end of 2003, the niche was dry-bonded to assess its overall accuracy and the accuracy of the individual cut moulded bricks of the body and the hood. This is always very important in cut and rubbed and gauged work, but particularly so with such a small-scale model to be set with fine joints. A suitably-sized plastic damp proof course acted to represent the joints in this process (Figures 116 and 117). The positions of the hood voussoirs were set out on the hood mould and radiated around to the striking point.

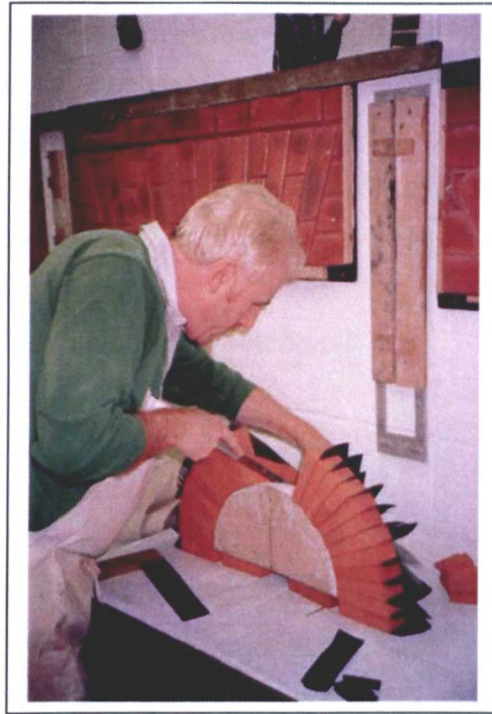


Figure 116 Dry bonding the hood of the niche.

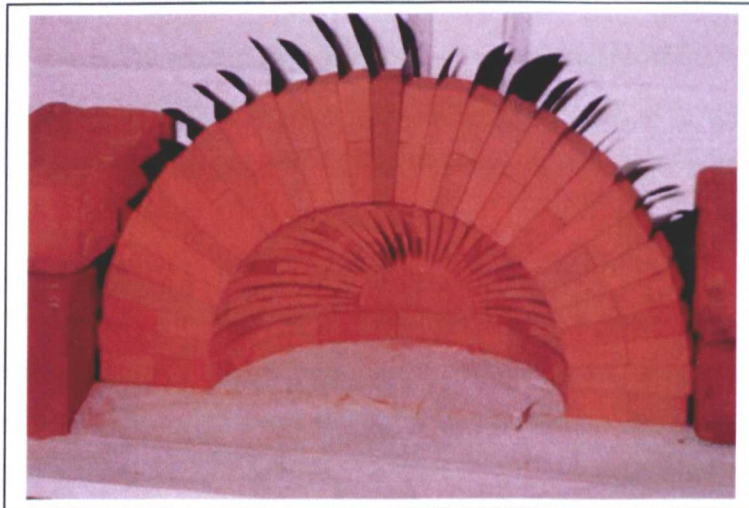


Figure 117 Dry bonded hood with hood mould removed.

Dry-bonding allowed the cuts to be assessed and adjustments made, if necessary, to achieve the accuracy desired, termed in the craft as 'humouring'. It also provided an opportunity to replace bricks that had been accidentally damaged, being unavoidable when using an old and inferior quality of TLB.

It was clear that there was a slight discrepancy in the bed joints of the voussoirs, which was difficult to account for given the care that had been taken at every stage of the work. It was eventually traced to an error in the elevation drawing from which the face

templets were obtained for the cutting boxes. The error was mainly centred on the second voussoir from the springing on the left-hand side, which in turn affected the radial alignment of all voussoirs necessary for parallel bed joints. Unfortunately it was impossible to correct at this late stage, as there were no original TLBs left from which to re-cut the entire face of the hood. Simon Douch studied the drawing and realised how the error had occurred. He explained that, on completion of the right-hand side, he copied and rotated it horizontally as a mirror image for the left-hand side. Unfortunately the image was placed on to the incorrect setting out line.

3.11 Setting the Niche

In order to build the niche, a timber platform was used. This provided a sturdy and level base. Because the niche is likely to be moved in the future and not built in its final resting-place, it was decided to set the work in whiting (crushed chalk) mixed with patent knotting (liquid shellac). This is a traditional mix, popular for setting 'lumps' to be carved or where strength was important.

The construction of the niche was in two distinct parts, the body and then the hood. The body, particularly in this instance when it is free-standing and not built in to surrounding masonry, needs to be allowed to set sufficiently to take the weight and thrust of the hood.

The execution of the body to such a small scale meant an innovative approach was adopted to ensure the accuracy of every brick was maintained as each course was laid. To this end, a steel square was adapted so that it was mounted, with an adjustable locking device, on to a steel plate located by a steel dowel in to the timber base on the exact striking (radial) point of the body. With the plate thus fixed and the square adjusted to the correct radius and locked secure, it rotated through 180°, which checked the accuracy of the built curve and ensured that each brick laid was sitting plumb, or at 90°, to the base (Figure 118). To further ensure that the brickwork was level across and around the body of the niche, adhesive tape was placed either side along the vertical arm of the trammelled square on to which was set-out the gauge of the brickwork, which checked the upper arrisses of each laid brick.

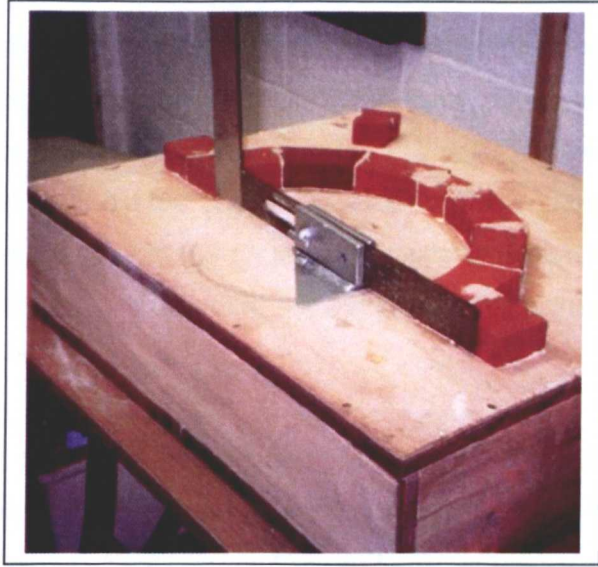


Figure 118 Steel Square rotated to check accuracy of courses whilst laying the niche body.

The preparation of the bedding mortar, of whiting and shellac knotting, had to be undertaken with care, especially as the joints are fine. The whiting was first placed in to a sieve and gently scraped to and fro to sift it through in to a collecting tray. The liquid shellac was then shaken vigorously to ensure all the segregated contents were fully integrated. An amount was then poured out in to a mixing receptacle. The sifted whiting was then added a little at a time and stirred in, until the mix was the consistency of cream (Figure 119). As this type of mortar begins to stiffen and lose flexibility relatively quickly, it is important to only mix as much as can be used successfully, which in this instance, was sufficient to lay two full courses.



Figure 119 Mixing the whiting and shellac mortar to the consistency of cream.

The course to be laid was dry-bonded around the body and each perpend marked with a pencil for its final position. Once agreed the bricks were carefully lifted off and brushed free of dust and then lowered in to a trough of clean water to soak to a point just short of saturation, which due to the small scale of the niche bricks was 30 seconds. This removed their excessive porosity that would stiffen the mortar before it could be used to set and hold the brick in to position. The soaked rubbers were then withdrawn quickly and placed in the order of laying upon absorbent paper to drain-off any unwanted surface water that would impede the mortar adhering to the bedding surfaces of the bricks.

The correct amount of whiting and knotting matrix was then applied to the rubber and quickly spread on to the bed with a plasterer's small-tool to achieve a full joint (Figure 120). Cross-joints were applied first, as they were the smallest, with the mortar being less likely to run down the face of the brick. The brick was carefully laid in to position so that a small bead of mortar exuded from the joint face. The brick was then checked at either end for accuracy with the rotating trammelled square. After the brick was placed, the exuded joint was carefully and neatly trimmed flush, the whole brick was double checked along its length and if necessary adjusted.



Figure 120 Applying the mortar bed to the pre-soaked rubber.

At the end of each session of building, the rear of the niche was checked for any voids and filled with waste mortar that had begun to stiffen. At the commencement of the next session of building, the top of the last course set was checked and the upper surface was gently rubbed smooth and level and then dampened to ensure it presented a

perfect bed for the next course. This procedure continued up to the springing of the hood (Figure 121).

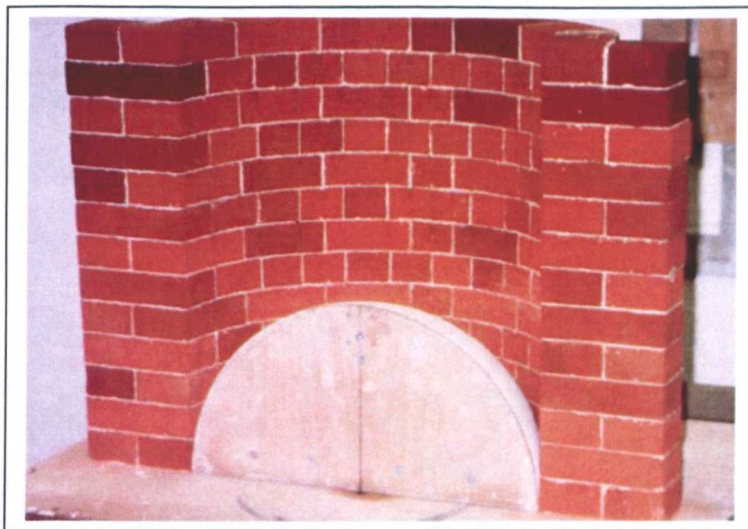


Figure 121 The body of the niche completed to the springing line of the hood.

3.12 Setting the Hood

It was necessary in constructing or 'turning' the hood to erect timber profiles to horizontal and vertical alignment, placed on either side and above the niche and the mould, upon which the hood would be turned.

The hood mould was carefully positioned in to the opening, rested on polystyrene, and cut to fit within the opening so that it would not contact and chafe the face and arrisses of the vulnerable rubbers of the body. It was yet able to support the weight of all the soaked voussoirs. The hood mould, with centre line and face voussoir soffit positions already marked on to it, was then set on a bed of mortar that facilitated adjustment to the correct springing line. String lines ranged across from the profiles to check face and radial alignment. The mould was subsequently wedged on either side of the bottom of the mould to prevent it dropping forward on the mortar. The centre line was re-checked and then plumbed on to the overhead profile. Finally, from a line pulled from a screw fixed at the striking point through the soffit marks on the hood mould, all the voussoir positions were transferred on to the profile.

The boss was then tried in its central position and marked on the hood mould, and the soffit positions drawn from the face on to the surface of the mould. To complete the setting out and bonding of the voussoirs, the entire cross joints were radiated up from the alternate body courses on either side to ensure all joints travelled up and across the

hood in line (Figure 122). The surface of the hood mould was given a dusting of French chalk to prevent the whiting and shellac mortar adhering to it, as it would unavoidably squeeze out from the soffit of the voussoirs during laying. This would make removal of the mould difficult and would almost certainly result in brick-face damage.

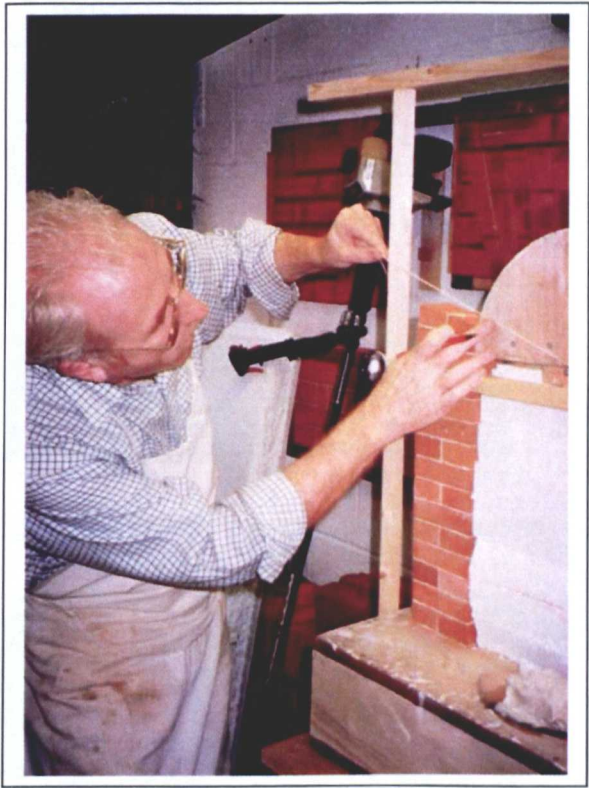


Figure 122 Radiating the arch face hood joints on to the timber profile.

Sufficient mortar was prepared to lay three courses on either side of the hood. The relevant bricks were dampened and set to line and position. The mortar exuding on to the face was left until sufficiently stiffened and then carefully cut away flush to the surface. Great care had to be exercised at all times during this phase, particularly with the thinnest bricks, because when dampened they became temporarily softer and liable to break when pressed on to the mortar bed. The hood was slowly and carefully constructed by raising it equally on either side, three lined-in courses at a time, working from between the brick abutting the boss and the arch face brick (Figures 123 and 124). This was a vital process of checking that the intervening bricks were laid straight up to the key brick position.

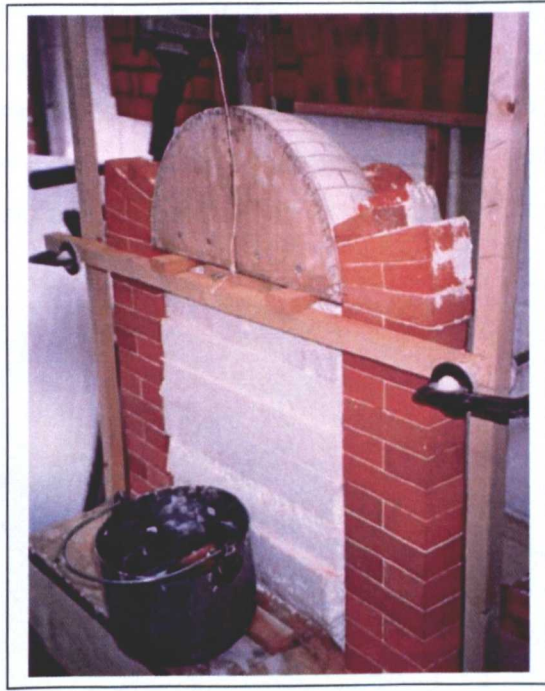


Figure 123 Turning the hood voussoir courses.

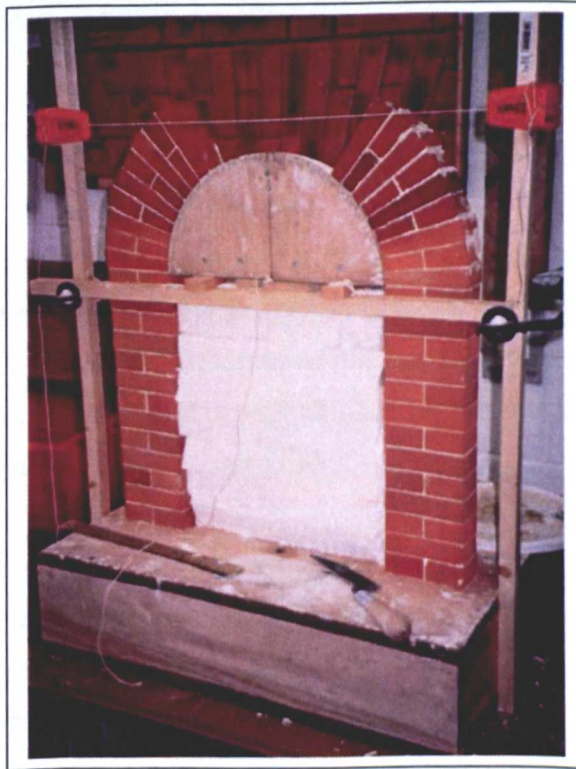


Figure 124 Turning the hood with lines to check face alignment.

The problem on the setting out drawing, as described above, led to an inaccuracy on the extrados of the voussoirs that made work on the hood particularly difficult. The loss of brick size at the extrados, in relation to the intrados, could have led to the hood falling out of line, so continual assessment was required to ensure that the voussoirs were bedded to accommodate this difference (Figure 125).

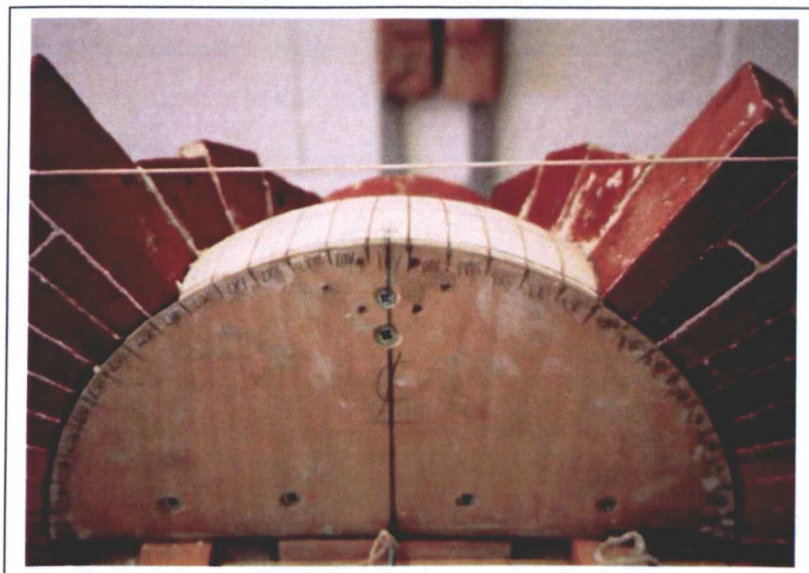


Figure 125 Laying to the soffit lines on the hood mould.

The key brick course was difficult to lay as one was restricted by the set bricks on either side. As one lowered the voussoirs of that course in to position, all sight was lost of the setting out line on the mould. Upon setting the final brick, the wedges on the mould were immediately eased and the mortar raked out to allow the hood mould to be carefully dropped and removed. This allowed the hood voussoirs to lock and gain tension before the mortar hardened. The final brick on the niche hood was also accurately checked and adjusted for alignment.

With the hood mould removed, and the body of the niche cleared of the polystyrene supports, it was then important to clean the soffit of all exuded mortar before it hardened fully, which could lead to the loss of the vulnerable arrisses. As the bricks were cleaned, all joints were checked for fullness and accuracy.

3.13 Dressing the Niche

All plumb marks were placed on to the stopped ends of the niche and these were carefully rubbed true. The entire face of the niche was then rubbed flush and plumb with the float stone, checking alignment between the vertical profiles. It was important in this dressing or 'finishing' phase to use the stone in an arced fashion across the face of the hood, so that the striations were radial in contrast to the other vertical abrasive marks (Figure 126). In rubbing up the soffit of the hood, it was important to use a float stone shaped to the inner curve, and this was used both radially around the face and towards the boss (Figure 127).



Figure 126 Rubbing up the face of the hood.



Figure 127 Rubbing up the soffit of the hood with a suitably curved float stone.

The arch voussoirs had been deliberately 'left long' to allow for rubbing to a radial extradossal line. A trammel was screwed to the striking point (on the temporarily re-positioned hood mould) and set to pick up the line of the plumbed stopped ends with a sharp nail. This was carefully rotated to scribe the line of the extradados, which was then carefully rubbed down to the line and checked with the trammel before removal and final vacuuming of all dust. At the conclusion of this process the niche was complete (Figure 128).



Figure 128 The completed niche masterpiece.

Summary

The scaled niche masterpiece entailed considerable planning, organisation, and craft skill to see it through all the stages of setting out, preparation, laying, and finishing during the course of this research. CAD drawings, from which cutting boxes were made, proved of benefit, and indicated that modern design techniques could be employed in this aspect of work. A mistake was, however, made in not checking the accuracy of the full-size computer drawings prior to templates for the cutting boxes being made. The

latter is something that the author would always undertake when creating drawings in a traditional manner based on manual geometry.

In the cutting and rubbing phases of the small-scale bricks used for the body and hood of the niche, it became apparent that the original TLB orange rubbers were incapable of being worked to produce sharp arrisses vital to achieve the fine joint size originally planned. Despite this, construction proceeded well, and with due care and attention to detail the niche was built. The author benefited tremendously in handling various traditional tools throughout the whole process of design and construction, which helped gain a clearer understanding of their employment. There can be little doubt that without prior knowledge and experience in gauged brickwork it would have been extremely difficult to construct such a complex enrichment and to successfully overcome the problems encountered.

4.0 MODERN RUBBING BRICK PRODUCTION

Only a handful of traditional brickmakers continue to provide rubbing bricks for gauged work, which affects the variety of rubbers now available. This is especially so for the repair and restoration of cut, rubbed, and gauged work on historic buildings. This contraction in manufacture has been mirrored by a steep increase in cost to levels that are of concern to all involved with traditional brickwork and its conservation.

Whilst rubbing bricks always commanded higher prices than standard bricks (typically 50-150% more), the current cost differential is several times greater, which has a clear effect on project costs. Colleges wishing to include gauged work as part of their curricula, cannot on the limited funds available, afford such expensive bricks, leading to a reduction in training opportunities and a long-term contraction of the skills necessary for the repair and restoration of historic brick buildings.

Though utilising quality top clays capable of making rubbers, no current traditional brickyard exploits the naturally high silica-bearing brickearths that were the raw material for the best rubbing bricks. Furthermore modern brickyards no longer fire their bricks using slower-burning and lower-temperature wood as a fuel, preferring labour-saving coal and liquid petroleum gas that burn quickly and rapidly reach temperatures well in excess of 1,000°C.

The significance of using such clays and high firing temperatures in excess of 1,000°C on the quality, workability, and durability of modern rubbing bricks forms part of the current research programme. The open-pore structure of modern rubbers, like historic rubbers, of significance in relation to the positive durability of the brick.

Currently however four traditional brick companies produce a selection of rubbers with varying degrees of associated services for cut, rubbed, and gauged work. These are W.T. Lamb and Sons (Bricks and Arches) Limited in Sussex; Bulmer Brick and Tile Company Limited in Suffolk; W.C. Reades of Aldeburgh in Suffolk and Michelmersh Brick and Tile Company Limited in Hampshire. H.G. Matthews and Sons of Buckinghamshire are working towards the production of a rubbing brick from their Chalfont Red range of hand-made bricks.

4.1 W.T. Lamb and Sons (Bricks and Arches) Limited

W.T. Lamb and Sons (Brick and Arches) Limited have been producing rubbing bricks for the longest period of time. For their red rubbers, they excavate and initially prepare their clay at their Faversham works in Kent, transporting it to the Pitsham yard by lorry. Their red rubbers are available in six colours – light orange through medium to plum red in colour - to suit various architectural applications. They continue to provide yellow and gault cutters out of their on-site clay reserves at Faversham.

The raw material from Faversham is won one metre deep below topsoil, once excavated, and over-wintered, it is washed, ground, and placed in a pit next to the pugging mill to mature for up to six months. In preparation for moulding it is then thrown in to a pugmill and conveyed by belt to the hand-moulding bench.

The wooden moulds - of box, beech, or teak - are dipped in water and sanded ready for the clot of clay to be thrown once it has been rolled in the same moulding sand. The green-moulded bricks are then removed for open stacking in covered hack sheds to dry naturally in readiness for firing. This takes about six weeks, during which the rubbers shrink by about 11%.

Lamb and Sons have two types of kilns available for firing rubbers -two traditional downdraught kilns and a modern batch fibre kiln, both fired by propane gas. The traditional kilns have a capacity of 40,000 and 30,000 bricks, of which 10-15% would be rubbers, placed for four courses maximum in the centre bolt of the mid-kiln position, the overall burning temperature ranging from 980°C to 1,140°C during a 72-hour cycle. The kilns are then left to cool for seven or more days.

Their modern computer-controlled kiln has a maximum capacity of 5,000 bricks, yet all of these can be rubbing bricks, stacked inside a special set block. The firing temperature, dependent on the type and colour of rubber/cutter required, will be in the range 980°C to 1,060°C over a 48-hour period; with a greatly reduced cooling time varying from as little as 8 up to 18 hours. Shrinkage is about 1% and loss is minimal.

Today Lamb and Sons TLB rubber range come in two degrees of firmness; soft for traditional carving and a harder cutter intended for in-house machine cutting and moulding with some hand finishing. In either respect Lamb and Sons have responded to

the present-day market conditions, whereby the lack of site crafting skills increasingly demands prepared gauged elements for on-site assembly only. They therefore offer a service of surveying details and providing designs for the specials and carved units with CAD packages. Machine cutting and moulding is achieved with bench-mounted disc cutters and reverse-moulded carborundum wheels (Figure 129), through which the harder rubbers are passed by the skilled cutters at the Pitsham workshop to match the full-size drawings and templets.



Figure 129 Machine cutting of rubbing bricks using reverse mould abrasives at Lamb and Sons workshop, Pitsham (Sussex).

Lamb and Sons are not currently supplying the oversized TLB and TLBHCP rubbers for on-site cutting and rubbing, unless specifically requested for bespoke work by a highly competent craftsman, but have recently (2004) communicated that they are exploring the reintroduction of a softer rubber. In respect to the latter, Lamb and Sons have continued to be particularly supportive of the author with their oversized rubbers, as well as purpose cut and moulded units, for his many master classes, lectures, and televised work.

Lamb and Sons also undertake carving for on-site assembly of enrichments, such as capitals and swags. All cut and carved bricks are then carefully packed, in numbered order, in timber delivery trays and shrink-wrapped to arrive at site in perfect condition. The overall accuracy of this entire machine cutting, moulding, and carving allows for setting on site with joints that can be as fine as 2mm, but generally 3 mm.

Lamb and Sons now also offer gauged brick flat arches, fixed with epoxy resin on to reinforced-concrete lintels, and jointed and then rubbed-up. These only require bedding across the opening in the manner of an ordinary lintel (Figure 130)

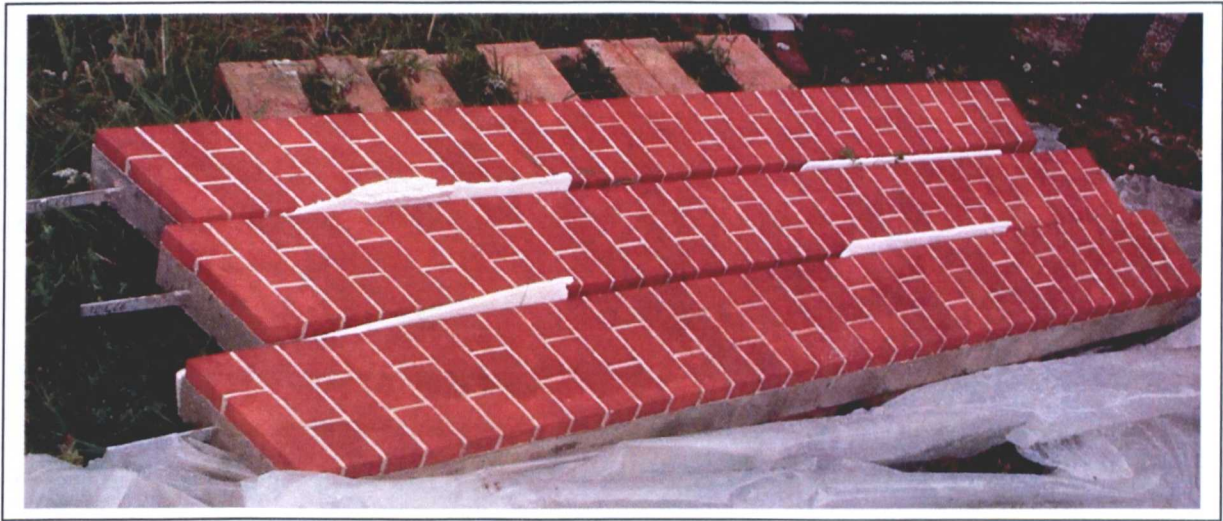


Figure 130 Gauged faced reinforced concrete lintels at Lamb and Sons workshop, Pitsham (Sussex).

4.2 Bulmer Brick and Tile Company Limited

Bulmer Brick and Tile Company Limited continue their product development and currently market two types of orange/red rubbing brick, pan ground and fully washed, as well as a buff cutter; all of which can be supplied to standard or requested sizes.

Their 10-metre thick seam of London Bed clay, just over a metre below ground level, is dug during late August-September using mechanical diggers and left to over-winter. It is then pulled down in to beds and soaked with water for up to 24 hours. With additional water, it is then put through one of three pug mills. For the 'fully washed' rubber the clay is blended to requirement, washed, screened, taken through a filtering process, and then stored to sour for up to four weeks. Sand is added to rubbers, the amount being dependent on the mix required.

The moulder sands his bench and draws down his warp of prepared clay and throws it in to the dampened and sanded timber mould box. The excess clay is then struck-off and the green brick turned out on to the pallet board ready for removal to dry. A good moulder will mould 200 to 250 oversized rubbers a day, depending on mix and size.

Drying takes place outside, at the hackstede, between March and October and inside, with artificial propane heaters and de-humidifiers, during winter. Rubbers take about four weeks to dry and are only pitched one row high. Shrinkage is 12%.

Firing takes place in a coal-fired intermittent downdraught kiln with a capacity of 12,000 bricks, of which 200-500 will be rubbers placed in the centre of the kiln. The fire is lit and built up over a total of four days, feeding coal every 1¼ hours during the two main days, reaching a temperature of up to 1,100°C. A three-day cooling period then follows. The overall loss is 1-2%.

Their two types of orange/red rubbers, pan ground or fully washed, both produce a firm brick responding well to machine-cutting or a softer rubber for traditional hand cutting. In line with their development of the various rubbing brick range, Bulmer Brick and Tile Company, in partnership with Colin Pinnegar, now offer the Bulmer Brick Cutting Services (BBCS), which seeks to offer traditional and modern requirements, including working drawings (Figure 131).

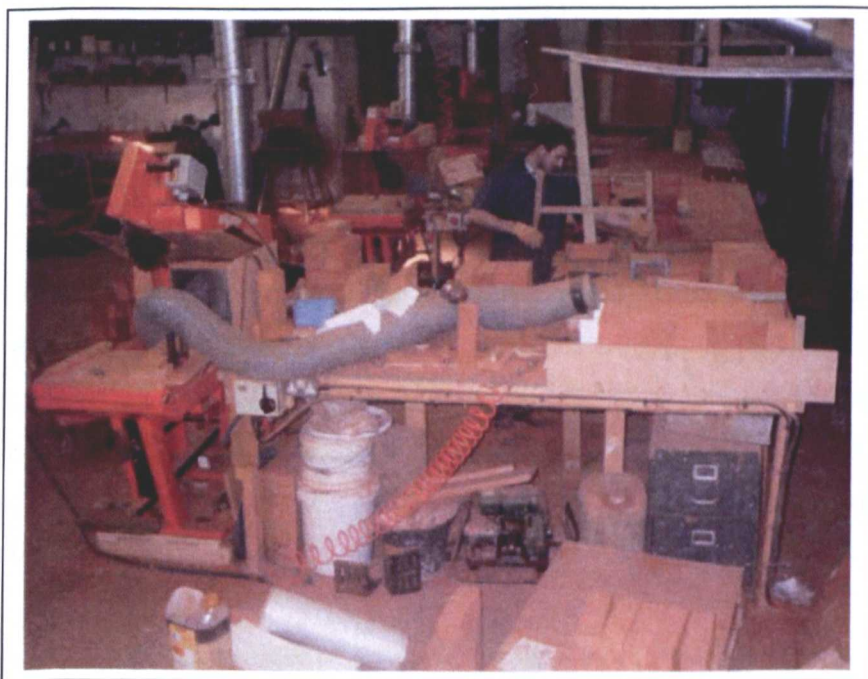


Figure 131 Machine and traditional bow saw cutting at Bulmer Brick Cutting Services, Sudbury (Suffolk).

They supply arches cut on the dry bench-mounted disc-cutting machine and gauged brick elements cut by bow-saw to profile and templet, and workshop carving for on-site assembly; intended to complement the traditional craftsman's practices. This service

also extends to supplying fully bonded solid arches, of rubbers cut to voussoirs, bonded and fixed with epoxy resin on to steel lintels (pointed or un-pointed) requiring only to be set in position (Figure 132).

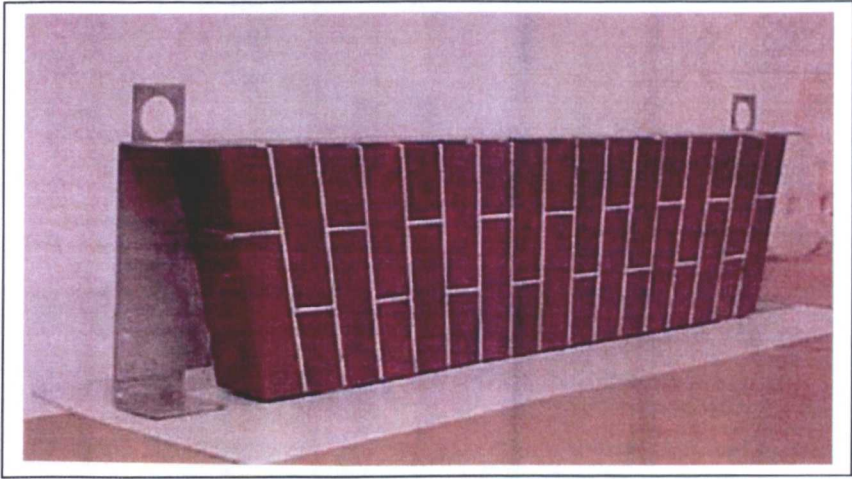


Figure 132 Gauged face steel lintels at Bulmer Brick Cutting Services, Sudbury (Suffolk), (Colin Pinnegar).

All bricks are palletted and shrink-wrapped for delivery. Purpose cut-moulded or carved elements are numbered and dry assembled in packing boxes and wrapped for despatch.

4.3 W.C. Reades of Aldeburgh

Production of the uniform red-coloured rubbers at the Aldeburgh Brickworks is much as it was in the 1980s. Besides various sizes of moulded voussoirs (Figure 133), requiring only rubbing, 'topping and tailing' to the relevant templet shape, Reades now offer three different sizes of oversized rubbers to facilitate bespoke cutting. Other brick companies who cut and supply purpose-made gauged arches for on-site assembly also buy many of their rubbers.

Their Chillisford Clay 450 mm below ground level and from 3.5 to 4.5 metres deep, is a very clean material, greasy, and moulds easily. It is machine dug and, to a given ratio, mixed with sand from a seam in the same pit. It is then soured for up to 15 months. Due to the inherent lack of major inclusions, it is no longer washed but only ground and then pugged ready for moulding.



Figure 133 Purpose-made rubbing brick voussoirs ready for dispatch at the Aldeburgh brickworks (Suffolk).

All rubbers are hand-moulded. The clay on the sanded bench is rolled in to a clot for throwing in to the dampened and sanded timber mould box. The excess clay is trimmed with the wire bow and smoothed with a timber 'strike'; the green brick then turned out on to a pallet and placed on to a drying tray for internal shed drying. The rubbers dry naturally during a three to four-week period. During the winter a gas-oil fired blower and under-floor heater are used.

Burning takes place in one of four fuel-oil, up-draught scotch kilns, each with a capacity of 36,000 bricks. The rubbers, as green-moulded specials, are set within a box within the upper part of the setting to protect from over-firing. The fire temperature is from 1,000°C up to 1,250°C over 50 hours, time dependent on the weather, with a cooling period of 5 to 10 days. The loss is negligible.

No in-house cutting service is offered and all bricks are delivered by contract haulier on shrink-wrapped pallets, or collected by the customer direct from their coastal brickyard.

4.4 Michelmersh Brick and Tile Company Limited

Michelmersh Brick and Tile Company Limited, based near Romsey (Hampshire), was founded in 1842 and records show that rubbing bricks have been produced in the area for over 150 years. To fulfil demand from customers for matching local arches, the company began offering purpose-cut gauged arches for on-site construction from their orange/red and red-multi ranges since the mid-1990s. This rubber range has a texture and appearance of many rubbers dating to before the mid 1850s.

All of Michelmersh products are produced from their Reading Bed Clay, varying in seam depth from 1.5 to 15 metres; and lies between 1 to 5 metres below ground level. Machine excavation is seasonal and enough clay is won to weather outside and produce a full year's brickmaking.

The matured clay is ground down in a Craven wet pan, at which point water is added to produce a slop that is stockpiled and soured for three days prior to use. When required, it is loaded in to a mixer/feeder to be conveyed to a pug mill in to which grogging sand is added to aid plasticity and open-up the body to facilitate improved drying. The total sand content, including the naturally occurring sand/silt, is between 48% and 51%. Water is added to maintain a moisture content of between 23.5% and 24.8%. Finally, in order to obtain the colour range required varying percentages of fine coal dust (breeze) is added. This breeze, it is considered, should not be used as it causes internal hardening within the rubber and so affects its quality.

The pugged clay is fed to the hand-moulders by belt feed, which they remove as required. The clot of clay is rolled on the pre-sanded bench and then thrown in to the pre-sanded timber mould with the excess being removed with the wire bow and the brick released from the turned-over mould on to a tray.

All the handmade products, including the rubbers intended for the gauged arches, are dried in computer-operated chamber dryers, with full temperature and humidity control. The cycle time is 45 hours, with moisture levels reduced from 24% to less than 2%. The gas-fired dryers can reach 90°C but generally operate at 65°C, with a fully controlled air flow to monitor critical shrinkage of about 8% on length, 10% on width, and 5% on height of a typical brick.

Firing can be carried out in any one of three kilns to produce the desired product. For example, for a light orange, they might place the brick in the top part of the intermittent or moving-hood kiln, yet for a redder hue bricks would be placed to the centre of the beehive kiln.

The intermittent up-draught kiln is gas-fired with a capacity for 10,500 bricks. The downdraught moving-hood kiln is oil-fired with a 45,000 brick capacity, and the downdraught, oil-fired beehive kiln has a capacity of 38,000. In any of these kilns, the rubbers make up about 5% of the brick total. The stacking position of the rubbers is chosen only to achieve a required colour, rather than protection from over-firing. The firing temperature and time varies with the kiln. For the beehive and moving-hood, a temperature of 1,050°C for two days is normal, yet, for the intermittent kiln, 1,020°C for 12 hours is standard. The expected loss also varies with kiln type, 3% with the intermittent kiln, 8% for the moving-hood and 10% the beehive.

Michelmersh can supply oversized rubbers but generally offer machine-cut gauged arches for on-site assembly. Their service extends to assisting the designer by sending out a representative to establish a colour/texture match and then determine the exact architectural requirements; with drawings utilising their on-site CAD program. All arch sets are numbered, dry-assembled in delivery boxes for despatch to the customer, protected by shrink-wrapping.

4.4.1 Rubbing Brick Trials

Mr Andrew Gardiner, Assistant Works Manager of the Michelmersh Brick and Tile Company over the course of several discussions and meetings with the author comments on the current and future production of rubbing bricks:

Until now it has been our belief that our clay does not lend itself to producing a fully fledged rubbing brick. Whilst the brick is soft enough to rub to size, once the brick face is rubbed it exposes a pitted surface rather than the close textured finish we've always associated with traditional rubbing bricks.

However, during our discussions it became apparent that, with modifications to our clay preparation - removing the breeze, using a finer grade of grogging sand and altering our firing process, we could possibly produce a brick suitable for rubbing in the traditional way.

At the moment we operate with a single clay preparation system feeding a factory producing 250,000 products each week. Our current ranges of facing bricks are all 'Multis' and dependant on the addition of breeze for their colour. Therefore, modifying our process to effect a trial into producing rubbing bricks would prove difficult. However, we do have plans to alter our current clay preparation system, which would enable us to undertake some small-scale trials in the near future.

Ultimately the decision to add rubbing bricks to our product range, if trials prove successful, has to be a commercial one. Questions such as: Would the introduction of a rubbing brick enhance sales or be at the expense of our existing cut arches and purpose made specials business? Also, are there sufficient bricklayers with the traditional skills to rub arches or carve specials on site? And are architects / specifiers aware of the existence of rubbing bricks for their projects? - All need to be addressed.

You have certainly shed some light on the whole subject of rubbing bricks. Thanks to your efforts it is reassuring to know that we are not that far away from being able to produce rubbing bricks, should demand be there [Gardiner, 2004].

4.5 H.G. Matthews and Sons Limited

H.G. Matthews and Sons are a well-established family firm of traditional brickmakers established in 1923, and produce between 50-70,000 bricks per week of which 15-25,000 are handmade. During the last decade the company has occasionally produced bricks capable of being rubbed. The intention of the company is to produce a rubber by modification of the clay preparation and firing techniques

James Matthews of H. G. Matthews Limited, has taken the lead in this initiative and in consultation with the author, agreed to focus on clay preparation and firing. For the clay preparation it was deemed necessary to increase the sand ratio, and to look at washing and screening the clay. It was agreed in this respect, that H. G. Matthews Limited would look at producing a washed and unwashed rubber, with the intention of achieving a broader range of bricks for aesthetic matching to different periods. With regard to firing, Mr Matthews was determined to fire at 900° C, and to seek to position the rubbers in the stacking arrangement in the kiln in a 'box' to maximise the potential of the firing process to produce a quality rubber.

4.5.1 Present Day Production

The orange through to dark-red standard brick is called a Chalfont Red and is made from a mixture of Chalfont Clay, that sits within a 6.5 metre seam about one metre below ground level, and sand. Machine excavation is seasonal and the won clay is mixed 50/50 in the pit or knott-hole. The clay is then passed through two sets of rollers, with water on the top set to extract flint, and then left out to weather. Four days before moulding this matured clay is pugged with water using a pre-mixer, extractor rolls, and crushing rolls; nothing is added.

The pugged clay is taken by conveyor belt to the hand-moulders benches. The clot is rolled in sand and thrown in to the pre-sanded timber mould of teak, the excess trimmed off with a metal strike, and the mould turned to eject the brick. The bricks are placed, about 50 at a time, on stillages under a wooden frame covered with corrugated Perspex to dry for 12 -14 days in ideal conditions; below-floor steam-heated radiator pipes supply heat.

The burning takes place in a gas-oil fired, up-draught scotch kiln with a capacity for 70,000 bricks. The firing temperatures are between 900°C and 1,100°C over 20-22 hours with a 48-hour cooling period. The loss in firing is about 2%.

4.5.2 Rubbing Brick Trials

Of these trials, Mr Matthews says:

Initially we took our standard Chalfont Red hand made facing brick to Gerard Lynch to see if it was suitable for a rubbing brick. Following discussion it was felt that although the brick showed promise and that further development was justified.

Trials proceeded on two fronts first the normal Chalfont red brick was fired at 900°C for 36 hours in our intermittent test kiln. A batch of Chalfont clay was mixed with extra sand. This was done in two ratios, one at 2 parts clay to one part sand, and another at one part clay to one part sand. These mixes were not sieved or put through the normal clay preparation system and so resulted in a coarse clay mix. After drying these bricks were placed into the top of our normal Scotch kiln, they were loose set in chambers that had been left in the normal bricks either side of the kiln, about four feet from the kiln walls in order to achieve a lower firing temperature.

The resultant bricks were taken to Gerard Lynch's workshop for rubbing and cutting trials. The normal Chalfont brick fired at 900°C was found to be still too hard although the colour achieved was most pleasing being light orange, we will now add this to our standard brick range. The bricks that were made using added sand were felt to be much nearer the mark, particularly the brick with the one part sand to one part clay. This rubbed well and cut very easily and precisely with the bow-saw. [Figure 134] It was also a remarkably close colour and textural match to the Warfield [Berkshire] rubbing brick (c. 1740), that was present in Gerard's collection of historic rubbers.

The next step is to make a batch of clay using one part Chalfont clay to one part sand. This will be washed and screened to remove lumps and stones and then the bricks made from this fired at around 900°C. This is now proceeding (April 2004), and the results are eagerly anticipated (Matthews, 2004).

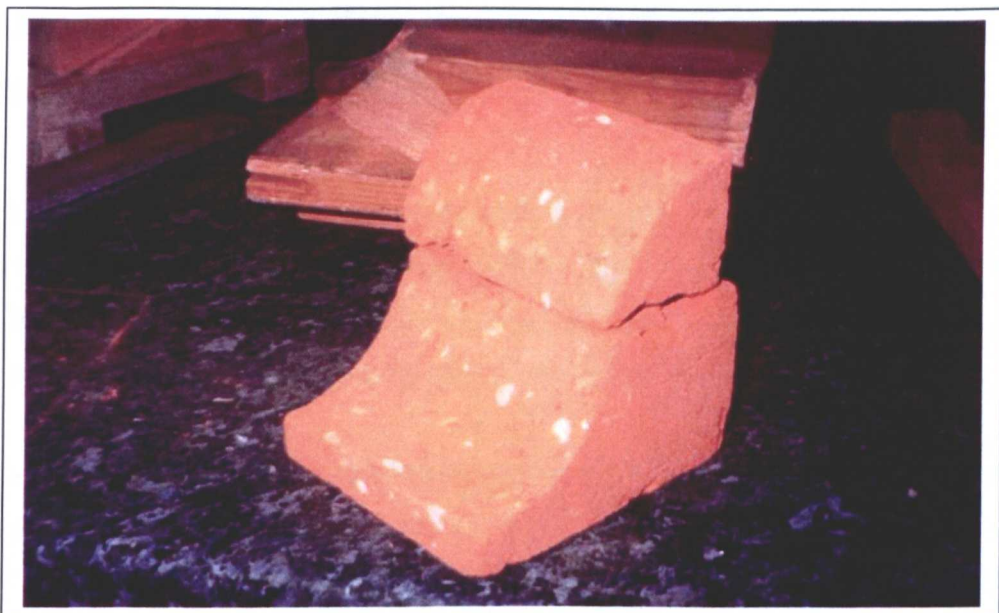


Figure 134 Initial trial rubbing brick, produced by H. G. Matthews Limited, cut to a cavetto moulding using a bow-saw.

5.0 ANALYSIS AND TESTING OF HISTORIC AND MODERN RUBBING BRICKS

Rubbing bricks, and particularly those made from fine-graded and washed brickearths, are soft in comparison to all other building bricks. Fired to a point just below vitrification (900°C), the brick possesses no fireskin, common to other fired bricks. Despite their softness and absence of a protective fireskin, these bricks are extremely durable.

Before such bricks are used, they are first soaked in clean water to enable them to pick up a fine mortar joint (1-3 mm) without the mortar rapidly drying out. When the brickwork is finished off, some weeks later, by rubbing smooth with an abrasive, hand-held, float-stone, it has been observed that a thin veneer forms over the surface of the brick, which is fairly hard to breach. Further hardening occurs over a longer period of time (several months) as the brick dries out, affecting its outer face.

The performance of modern rubbing bricks compared to their historic counterparts is important in terms of both conservation works and informing future production of such bricks. To these ends, a series of tests and analyses were carried out on a selection of historic and contemporary rubbing bricks.

5.1 Practical Testing in the Cutting of Historic and Modern Rubbing Bricks

The practical testing of rubbing bricks was undertaken to assess and compare how easily and quickly each one rubbed and cut. Rubbing was carried out on the rubbing stone and cutting by the use of a twisted wire blade in a bow saw. Due to the rarity of most of the historical bricks, only two bricklayers undertook the testing, excepting for the TLB Orange Red rubber of which an ample supply was available. For the modern rubbers, six bricklayers took part in these tests (Figures 135 and 136).



Figure 135 A traditional TLB prior to cutting on the left alongside four modern rubbers.



Figure 136 A traditional TLB after cutting on the left alongside the four modern rubbers.

5.1.1 Results and Discussion

Generally, the historic rubbers performed well and cut relatively easily to form sharp arrises and revealing only minor inclusions. The results of the tests are given in Tables 3 and 4, and the findings summarised below:

- The Wheeler Brothers' rubber, though quite firm, produced an excellent arris.
- The eighteenth century Berkshire rubber, apart from a less clean body (from as-raised clay), performed exactly as a twentieth-century TLB Orange Red made from the same, but washed, material.

- The two types of TLB clearly revealed why the Cherry Red was the superior rubber. Both were open-textured but the Cherry Red was less sandy and had a finer dust; both cut and rubbed very easily.
- It was interesting to note how the rubber used for the ashlar gauged work and niche body at Eltham was much firmer than the rubber selected for the carved niche boss.

All the modern rubbers, except the Hampshire rubber, proved much harder, although they still cut and rubbed well, with good arrisses:

- The Sussex rubber was quite dense and, although it had few air pockets, was speckled with tiny flint nodules and was quite hard to cut.
- The washed Suffolk rubber, although dense in texture, cut reasonably well with few inclusions or air pockets and finished well with abrading and good arrisses.
- The unwashed Suffolk rubber was noticeably harder to cut, especially towards the middle, with large inclusions, yet it finished well with good arrisses.
- The Hampshire rubber cut the easiest of all the modern rubbers, but due to coarse sand content had fragile arrisses that needed care. The integral breeze was evident in a flash burn towards the exposed core of the brick.
- The Buckinghamshire rubber, rubbed and cut well with sharp arrisses, and the inclusions presented little resistance.

The opinions of those that took part in these tests was that, generally, most of the modern rubbing bricks tend to compare with the washed rubbers from the mid-nineteenth century onwards and some of the earlier, better quality, naturally clean-bodied bricks, in respect of texture and appearance. The Hampshire and Buckinghamshire rubbers have a texture and colour that particularly complements some sixteenth-, seventeenth- and eighteenth-century gauged work and is very soft to cut and rub, although the integral fuel of the former can sometimes cause the brick to burn harder than acceptable for a consistent rubbing brick quality. The overall hardness of the others would seem to confirm that modern rubbers are burned to a higher temperature than their historical counterparts and therefore do not cut and rub quite so readily. Clearly, in terms of cutting, the majority of these modern bricks are suited more towards machine cutting than hand cutting, although all can be cut by hand tools. It was certainly agreed by all that it would have been very difficult to cut and rub such bricks to the small scale required for the niche masterpiece discussed in section 3.

Name	Location of bricks or building source	Date	Type of brick	Colour	Observations	Duration of cut (min:sec)
Wheeler's Rubber	Originally from Berkshire St. Pancras station	c.1868	Voussoir moulding	Cherry red	<ul style="list-style-type: none"> Dense smooth and relatively hard to cut Arrisses very crisp Very few inclusions 	ES 0:58 GL 0:48
Wheeler's Rubber	St Pancras station	c.1868	Ashlar	Orange	<ul style="list-style-type: none"> Dense, smooth, easier cut. Polished texture Fine arrisses Few inclusions 	ES 0:58 GL 0:50
TLB Cherry Red	Bracknell (Berks.) From authors collection. Originally from Bedford Park	c.1887	Squint quoin cut moulding	Darker red than TLB Orange/Red rubber	<ul style="list-style-type: none"> Light, open textured feel. Not as dense as Wheeler's Rubber Holds good arrisses (but not as good as Wheeler's Rubber) Not many inclusions but gave scratch marks when rubbed. Unusually regular striations from bow saw 	ES 0:27 GL 0:20
TLB Orange Red	Bracknell (Berks.) From authors collection	c.1960	Rubbing block	Orange	<ul style="list-style-type: none"> Beautiful, light open texture Slightly less crisp arrisses than the Cherry Red TLB Hardly any air pockets or inclusions 	ES 0:22 GL 0:20 AL 0:35 DW 0:45 DD 0:20
Unknown	Warfield House, (Berks.). In the immediate location of TLB works, but prior to production of TLBs (when clay would have undergone washing for rubbers)	c.1740	Cornice moulding	Light orange (similar to the niche TLBs)	<ul style="list-style-type: none"> Very fine dust. On rubbing, surface revealed many air pockets and an almost marbled appearance with unbroken clay nodules. Light feel. Arrisses good, rubbed well Inclusions - air pockets 	ES 0:28 GL 0:18
'F' in frog of rubbers on main elevation. Identical 'F' found in bricks at H.C.P. yard	Eltham Orangery Niche, London	c.1710	Main body niche brick	Dark orange	<ul style="list-style-type: none"> Rubbed beautifully Surprisingly little dust Heavier feel than TLBs Good arrisses Inclusions - a few stones (flint?) Minor air pockets Light marbling effect of unbroken clay but not pronounced. Quite hard to cut 	ES 1:23 GL 1:07
'F' in frog of rubbers on main elevation. Identical 'F' found in bricks at H.C.P. yard	Eltham Orangery Niche, London	c.1710	From boss shell carving quality	Dark red colour	<ul style="list-style-type: none"> Dense Very sharp arrisses Inclusions - less air pockets or stones Whiter marbled streaks of clay Easy to cut 	ES 0:55 GL 0:47

Table 3 Results of practical tests on cutting historical rubbing bricks.

Key: GL = Gerard Lynch, ES = Emma Simpson, AL = Andrew Langridge, DW = David Watts,

DD = Derren D'Archambaud.

Name	Location of bricks or building source	Date	Type of brick	Colour	Observations	Duration of cut (min:sec)
Company 1	Suffolk	2002	Rubber	Dark orange	<ul style="list-style-type: none"> Dense texture Arrisses good Few inclusions or air pockets Washed Quite hard Finished nicely with abrading 	ES 0:45 GL 0:40 AL 0:45 DW 1:15 RD 1:07 DD 0:42
Company 2	Sussex	2002	Rubbing Brick	Dark red	<ul style="list-style-type: none"> Very dense and smooth Excellent arrisses A few air pockets. Speckled tiny white nodules-flints-though washed Hard to cut 	ES 1:31 GL 1:20 AL 1:55 DW 2:10 RD 2:03 DD 1:23
Company 3	Hampshire	2002	Rubbing Brick	Dark grey and reddish brown	<ul style="list-style-type: none"> Light, open, sandy texture Coarser sand/dust to others Core breeze included in mix resulting in evidence of flash burn towards core of brick Fragile arrisses - needed care Air pockets and small inclusions 	ES 0:26 GL 0:20 AL 0:50 DW 1:35 RD 1:05 DD 0:20
Company 4	Suffolk	2002	Rubbing Brick	Lighter orange red	<ul style="list-style-type: none"> Dense unwashed clay Good arrisses Large inclusions Hard to cut towards middle Finished nicely 	ES 1:45 GL 1:07 AL 1:15 DW 2:00 RD 1:47 DD 1:13
Company 5	Buckinghamshire	2004	Trial Rubbing Brick	Light orange red	<ul style="list-style-type: none"> Very fine dust On rubbing, surface presented an almost marbled appearance with unbroken clay nodules Light feel Arrisses good, rubbed well Inclusions 	ES 0:55 GL 0:45

Table 4 Results of tests on cutting modern rubbing bricks.

Key: GL = Gerard Lynch, ES = Emma Simpson AL = Andrew Langridge, DW = David Watts, RD = Ron Denton, DD = Derren D'Archambaud.

5.2 The Characteristics and Properties of Rubbing Bricks

The performance of a building material in relation to site and environmental conditions is determined by its mineralogical composition and physical properties. A brick is composed of minerals and pores arranged in a certain pattern. The nature of these minerals and the relationships between them will determine key properties such as porosity and hardness, thus dictating the physical and chemical resistance of the material. The nature of their raw materials, as well as their firing temperature and firing process affects greatly the final mineralogical composition, porosity, and durability of the material, and therefore the final quality of the brick. In general, high temperatures and/or long firing periods will result in a harder, less porous, and more vitreous brick.

It is, therefore, considered essential to determine the mineralogical composition and texture of the brick, with a particular focus on the presence, nature and arrangement of the mineral cements, in order to understand the properties of the rubbing brick in relation to durability. To this end, petrographic microscopy and X-ray diffractometry (XRD) were used.

Furthermore, since moisture is directly responsible for many decay processes and mineral reactions that induce hardening, the presence and movement of moisture within the brick were considered important factors. Porosity, water absorption and water suction were therefore measured in order to characterise the moisture transport properties of the rubbing brick.

5.2.1 Methods

In the first instance, ten samples of rubbing brick from a variety of locations in England and continental Europe, dating from the seventeenth to the twentieth century (Table 5) were analysed (Pavia and Lynch, 2003).

All analyses and testing were carried out at Trinity College Dublin, the Dublin Institute of Technology and Loughborough University.

Sample	Date	Provenance	Details
1	1682	Gate pier Chiswick Park, England	Mortared in place
2	1950	Thomas Lawrence & Sons, Bracknell, England	Known as 'TLBs'. Never used. Kept dry
3	1856	Arch Weaver's House, New Wanstead, England	Known as 'Malm Cutter' from Malm clay of London stock bricks. Mortared in place
4	C17th	Unknown church, The Netherlands	Mortared in place
5	c.1500	Outside Brugge, Belgium	Mortared in place
6	1999	Traditional brickyard, England	Washed clay (London bed). Never used
7	1999	Traditional brickyard, England	Pan ground. Not washed (London bed clay). Never used
8	1999	Traditional brickyard, England	Washed clay. Never used
9	1999	Traditional brickyard, England	Carving quality rubber. Never used
10	1999	Traditional brickyard, England	Never used

Table 5 Samples of analysed rubbing bricks.

Thin sections were made from the samples and petrographic examination was carried out using both natural and polarised transmitted light.

The mineral composition of the samples was determined by XRD.

The presence and movement of water within the brick samples was determined by measuring the rate of water uptake (suction) of a dry brick and the amount of water that the brick could hold (absorption). The amount of water absorbed by each sample was determined by comparing the wet mass of the sample to its dry mass.

The volume of pore space in the brick samples (porosity) was also measured. Open porosity, or porosity accessible to water, is the ratio of the volume of the accessible pores to the bulk volume of the sample.

5.2.2 Results and Discussion

The mineralogical compositions of the bricks are given in Table 6.

	Quartz	Feldspar	Calcite	Filosilicates	Diopside	Wollastonite	Haematite	Goethite
1	XXXX	XXX	(X)	X	T		X	X
2	XXXX	XX		X			X	
3	XXXX	XXX	(X)		XX	X		
4	XXXX	XX	X	(X)		X	(X)	
5	XXX	XX	X		X			
6	XXXX	XX					X	
7	XXXX	XX	(X)	X			XX	
8	XXXX	XXX					X	X
9	XXXX	XXX	X	X			X	X
10	XXXX	XXX	X	X			X	X

Table 6 Mineralogical composition of the rubbing bricks.

Key XXXX=predominant; XXX=abundant; XX=significant; X=present (X)=scarce; T=traces

From the results, the analysed rubbing bricks can be divided in to two main groups: those that contain calcium-bearing minerals (diopside and wollastonite) (samples 3, 4 and 5); and those that are haematite-rich (samples 2, 6, 7, 8, 9 and 10). Sample 1 could belong to either of these groups, although only trace amounts of diopside were observed.

Microscopic examination showed that most of the bricks contain a reactive chert temper (microcrystalline silica), which at some time has reacted with the surrounding matrix, resulting in reaction haloes and the generation of cements. The temper (defined as those phases with a diameter of $> 15 \mu\text{m}$) varies in size, from $50 \mu\text{m}$ to 1.5 mm . The calcium-bearing bricks tend to feature the finest temper ($50\text{-}100 \mu\text{m}$), whereas the haematite-rich bricks contain coarser temper (up to 1.5 mm in sample 10), and hence exhibit a more porous and open microscopic texture.

The petrography shows that the historic rubbers were probably fired at a temperature of $750\text{-}900^\circ\text{C}$, whereas the modern rubbing bricks were more likely to have been fired around the 900°C mark.

The measured porosity, water absorption, and water suction of the rubbing brick samples are given in Table 7.

	Sample	Porosity (%)	Water absorption (%)	Water suction (gcm ⁻² /min)
Calcium-bearing bricks				
	3	42.73	18.60	0.73
	4	38.82	17.16	0.52
	5	38.05	21.24	0.55
	Mean $\pm \sigma$	39.87 \pm 2.51	19.00 \pm 2.10	0.60 \pm 0.11
Haematite-rich bricks	1	32.41	14.00	0.47
	2	34.26	12.44	0.19
	6	35.65	15.07	0.40
	7	32.68	14.04	0.30
	8	32.15	11.99	0.30
	9	30.15	11.33	0.43
	10	35.56	15.07	0.44
	Mean ($\pm\sigma$)	33.27 \pm 2.00	13.42 \pm 1.50	0.36 \pm 0.10

Table 7 Properties of the rubbing bricks related to the presence and movement of water.

Even though the haematite-rich rubbing bricks show a more porous and open microscopic texture, the results show that the calcium-bearing bricks have a significantly higher effective porosity (volume accessible to water) and water absorptivity, and a slightly higher ability to absorb water by capillary action (suction). The mean porosity value for both the calcium-bearing bricks and the haematite-rich bricks (39.87 ± 2.51 and 33.27 ± 2.00 , respectively) fall within the typical range of historic hand-made and machine-made bricks (see Table 8).

The average value of water absorption for the calcium-bearing bricks (19.00 ± 2.10) is similar to that of the historic hand-made range. The haematite-rich group, on the other hand, has a significantly lower water absorption value (13.42 ± 1.50) than the reference values given. The mean water suction values for the two groups (0.60 ± 0.11 and 0.36 ± 0.10), however, are both significantly higher than the reference values given. The difference in physical properties between the two groups could be due to differences in firing temperature.

	Brick type	Reference values		
		Porosity (%)	Water absorption (%)	Water suction (gcm ⁻³ /min)
Hand-made range	Irish, seventeenth century (mean of 10 samples)	36.15	18.47	0.08
	Spanish, seventeenth century (mean of 19 samples)	37.13	21.29	0.22
Machine-made range	Gault facing	38.5	-	-
	Keuper marl	24.6	-	-
	Flettons	34.8	-	-
	London stock	48.9	-	-

Table 8 Reference values for porosity, water absorption, and water suction of historic, hand-made, and machine-made clay bricks (Pavia and Lynch, 2003).

The results have shown that the historic and contemporary rubbing bricks can be distinguished from each other through both their mineralogical content and physical properties. In order to substantiate the mineralogical difference, a further 10 historic and 18 contemporary rubbing brick samples (Table 9) were sampled and subjected to mineralogical analysis (XRD).

The mineralogical compositions of the samples (Table 10) have not revealed any distinctions between the historic and contemporary rubbing bricks, and no calcium-bearing minerals were identified in the historic samples. Five out of the 10 historic rubbing bricks showed the presence of goethite, an iron mineral formed during the firing process. As this is often found in contemporary rubbing bricks (see Table 6) it is not, therefore, considered to be a discriminating factor.

Sample	Date	Provenance	Details
11	c.1547	Hill Hall, Essex	Cut and rubbed moulding brick for a plastered fireplace
12	c.1717	Eltham Orangery, London	Rubbers from the niche – the body (light orange)
13	c.1717	Eltham Orangery, London	Rubbers from the niche – the boss in hood (dark orange)
14	c.1740	Warfield House, Berkshire	Rubber from remains of gauged cornice – close to the TLB 19 th century works
15	c.1887	Bedford Park, London	TLB red rubber No.1 quality
16	c.1867	St Pancras Station, London	Wheeler red rubber
17	c.1930s	Cornard Brick Company, Suffolk	Rubbing brick – not used but weathered
18	c.1920s	Allen's of Ballingdon, Suffolk	Rubbing brick – not used but weathered
19	c.1950s	Thomas Lawrence of Bracknell	TLB rubber, orange, 2 nd quality – soaked in water
20	1950	Thomas Lawrence of Bracknell	TLB rubber – never used and kept dry
21	2003	Company 1	Pan ground rubber – never used
22	2003	Company 1	Pan ground rubber – soaked in water
23	2003	Company 1	Mild clay rubber
24	2003	Company 1	Mild clay rubber – soaked in water
25	2002	Company 1	Fully washed rubber – soaked in water
26	2002	Company 1	Fired washed rubber
27	2002	Company 1	Fired unwashed and pan ground
28	2002	Company 2	Rubber for carving – soaked
29	2002	Company 2	Rubber for carving – never used
30	2002	Company 2	Rubber – soaked
31	2002	Company 2	Red rubber – fired
32	2002	Company 3	Orange/red rubbing brick – soaked
33	2002	Company 3	Orange/red rubbing brick – fired
34	2002	Company 4	Unwashed rubber brick – soaked
35	2002	Company 4	Fired rubber – moulded as an over-sized arch voussoir
36	2002	Company 5	Light multi – low fired with breeze
37	2002	Company 5	Red – fired
38	2002	Company 5	Imperial handmade third – to be refired

Table 9 Samples of historic and contemporary rubbing bricks analysed for mineralogical composition.

Sample	Quartz	Haematite	Goethite	Feldspar	Kaolinite	Muscovite	Coesite
11	X	X	X	X			
12	X	X	X	X			X
13	X	X	X	X			
14	X	X	X	X			
15	X	X		X			
16	X	X		X			
17	X	X	X	X			
18	X	X		X			
19	X	X		X			
20	X	X		X			
21	X	X		X	X		
22	X	X		X			
23	X	X		X			
24	X	X		X			
25	X	X		X			
26	X	X		X			
27	X	X		X			
28	X	X		X			
29	X	X		X			
30	X	X		X			
31	X			X			
32	X	X					
33	X	X					
34	X	X		X			
35	X	X					
36	X	X					
37	X	X			X		
38	X			X		X	

Table 10 Mineralogical composition of historic and contemporary rubbing bricks.

5.2.3 Conclusions

It is likely that the historic rubbing bricks were fired at slightly lower temperatures than their modern counterparts. This would explain the difference in physical properties observed, as a lower firing temperature would result in a greater porosity.

Apart from the usual cements generated through firing (e.g. haematite and goethite), a number of additional mineral cements were microscopically observed, interspersed within the brick matrix. These arose from reactive minerals contained within the temper of chert and volcanic rock fragments. This reactive temper was found to form reaction haloes and cements in the surrounding matrix.

The petrography of these reaction haloes and cements is very similar to that of hydraulic reactions involving certain types of pozzolans. These have been often observed during petrographic analysis of hydraulic lime mortars (Pavia, 1995-2001). The petrography of the reaction haloes and newly-formed cements in the rubbing bricks suggests that the temper was probably activated when the bricks were soaked prior to using. The temper within the rubbing brick – rich in microcrystalline silica – is acting in a similar manner to a pozzolan in a hydraulic lime mortar. The temper has reacted with lime in the presence of water, forming reaction haloes and cements in the surrounding matrix.

The great ability of the historic rubbing bricks to absorb water by capillary action, together with their high porosity, implies that their fine pores are better inter-connected and more effective at transporting water, than the coarse, open pores of the modern rubbers. This high efficiency in transporting fluids allows free movement of water throughout the brick, and, therefore, does not restrict the local crystallisation of cements from solution.

Although modern rubbing bricks may be considered to be low fired, in comparison with other building bricks, they have probably been fired at a higher temperature than their historic counterparts, resulting in slightly different physical properties.

In both cases, however, the firing temperature has been sufficient to induce sintering. It is this sintering process, and the presence of reactive temper, inducing localised cementation, that are the main contributors to the observed durability of the rubbing bricks.

Further research is needed to investigate the differences in physical properties between historic and modern rubbing bricks and their effect on mineral cementation and related durability.

6.0 Discussion

Gauged brickwork is an English term defined as brickwork where a superior finish in the detail of an important brickwork elevation is required, such as moulded reveals, arches, string courses and other forms of ornamentation. The term may appear paradoxical as all brickwork may be considered gauged, but it serves to distinguish a special branch of bricklaying work to very accurate measurements, which raised artisans of the craft to the status of masons.

The bricks for this class brickwork have, in England, always been referred to as 'rubbing bricks' or 'rubbers'. A 'rubbing brick' or 'rubber' can be defined as a masonry unit, made from a brickearth or topmost clay, possessing, high natural silica content. It is low-fired, or baked, to a point just below vitrification (900°C) so the resultant burnt brick possesses no fireskin normal to other fired bricks. The rubbing brick has the same uniform characteristics of soft body and close texture throughout. This allows it to be worked in a post-fired state so that it can easily be cut, carved, filed, and rubbed (abraded) to present smooth accurate finishes and sharp arrises (edges) without detriment to its long-term durability. In England, for several centuries, this has made the rubber prized for use on all forms of enrichments where precision and fineness of joints were essential in the days that preceded the mass production of mechanised quality-controlled and regular-shaped bricks.

The knowledge and skills of working bricks in their post-fired state have had a long and significant history in England, directly influenced by the immigrant Flemish masons/bricklayers, who were active here, particularly in the years between 1410 to 1485. These were acknowledged masters in crafting bricks as if they were stones for Gothic enrichments on ecclesiastical, municipal, and private properties in their native Flanders, where brick was the principal masonry element.

From drawings of the proposed enrichment, the hewer would obtain full-size templets and, with craft tools and techniques adopted from stonemasonry, 'cut and rub' the selected low-fired bricks, which were judged capable of being worked post-fired, to the desired shape. The primary tool for cut and rubbed work was the brick axe and the accounts for Kirby Muxloe Castle (Leicestershire), for the winter of 1482, reveal large

numbers of brick axes being sharpened every two weeks, emphasising how much this tool was employed.

By the Tudor period native craftsmen had fully absorbed the skills, and explored further possibilities of cut and rubbed work to wonderful architectural effect, this being demonstrated on the ornate chimney stacks for which the period is particularly noted.

Study of the axe marks on Tudor cut brickwork, along with practical tests carried out by the author and invited craftsmen and women, reveal how the brick axe was commonly employed to hew and finish a shape. Its use to dress the stretcher and header faces on oblique quoins and reveals would appear to arise from the need to flatten bloated faces common on some moulded bricks of this period. On some shapes the axe was used to cut along its length, as on a roll moulding, whereas on concave or convex mouldings it was used parallel to them. It could also be used in the manner of a carpenter's wood chisel, to pare or gouge the desired profile.

Some brick mouldings were cut on green (unfired) clay during the drying stage prior to being fired, most likely when the brickmaker was also a bricklayer, skilled in setting out and cutting such shapes. It needed to be carried out within a very short time slot in the drying cycle of the green brick, however, to prevent dimensional differences due to on-going shrinkage, and the problem of distortion during firing remained. It was observed that some faces on green cut moulded bricks tend to de-laminate over time, exposing the brick to decay.

The Jacobean and Restoration periods witnessed the demise of Gothic due to the increasing influence of the Renaissance style of architecture. The desire to refine brickwork to display classical features became ever more pressing, and the quality of brickmaking and bricklaying improved. The continental influence on post-fired working of bricks in England was now from the Netherlands and in particular the provinces of North and South Holland. When master mason Nicholas Stone (1586-1647) returned after six years working in Amsterdam under the influence of his father-in-law, the master mason, sculptor, and city architect Hendrick de Keyser (1565-1621), he introduced what later became termed the Artisan Mannerist Style in to England. This was advanced by influential city master bricklayers, such as Peter Mills (1597-1670), and was particularly popular in the years between 1630 and 1660. This style facilitated a much higher quality of cut and rubbed brickwork for classical enrichments on

properties such as Kew Palace (London) (1631), Cromwell House (London) (1637), and Tyttenhanger Park (Hertfordshire) (1655).

Kew Palace is usually cited as the building on which gauged brickwork was first introduced in to England. It is perhaps better described as a good example of the gradual transition of the Artisan Mannerist Style of employing brickwork from the earlier Tudor Gothic, prior to the later and more refined classical use of the true Dutch style of post-Restoration gauged work. On the north elevation of Houghton House at Ampthill (Bedfordshire) (1615) is the remains of an entrance loggia, constructed of ashlar and gauged work thought to date from later additions to the property during the early to mid-1620s. It is significant because, despite lacking the highly disciplined nature of post-Restoration gauged work, it pre-dates and is of a much finer finish than that of Kew Palace.

The post-Restoration period heralded a golden age of English brickwork, influenced directly by the use of brick and craft practices of the Netherlands, particularly in Amsterdam where the refined skills of gauged work had developed. Many prominent aristocrats and wealthy gentlemen returned to England after exile during the years of the Interregnum (1649-1660), and some were keen to build in architectural styles they had seen on the continent. Native bricklayers, particularly in London, easily absorbed these advanced Dutch skills. The finest bricks, high in natural silica or sand and baked to a point just short of vitrification, were now classed as rubbing bricks or rubbers, and were reserved for this new class of very accurate cut and rubbed brickwork.

The improvement in the accuracy and quality of the setting out, cutting, and finishing, saw rubbers cut precisely allowing them to be laid with joints as fine as 0.8 mm, led to the term 'gauged work'. Finely jointed brickwork was a part of the classical tradition of reducing the impact of masonry units so the architectural elements were displayed from a homogenised surface. Though the axing marks might still be left visible on the completed brickwork, it was generally finished smooth by rubbing over the entire surface with a hand-held stone.

The Great Fire of London in 1666 destroyed many medieval timber properties. The Building Act of 1667 ordained brick was to be the main building material, and that 'the ornaments and projections of the Front-Buildings to be rubbed Bricks'. In the highly skilled hands of the English bricklayers, working to the designs of Wren, Hooke, May,

and Pratt, gauged work became the finest expression of brickwork entirely suited to the new architectural fashion of the period.

Bricklayers recruited from the surrounding counties assimilated knowledge and skills of gauged work whilst working alongside city craftsmen during re-building work in London after the Great Fire. This, as well as Moxon's *Mechanick Exercises* on bricklaying of 1703, served to spread nationally the knowledge and skills of gauged work, beyond the close confines of the Bricklayers Company and London, as the craftsmen returned home to their native shires. This trend helped pave the way for the building practices of the following Georgian period.

Study of Moxon's craft treatise reveals the emphasis on gauged work as the primary means of producing brick ornamentation on the principal elevations of brick properties during the late seventeenth and early eighteenth centuries. All the main craft tools and techniques to produce elements of gauged work are detailed by Moxon for the benefit of both craftsmen and designers.

The following Georgian period, though a consolidation of the style of precise gauged work of the post-Restoration period, saw its use becoming increasingly tame and style-bound as the influence and personal input of the master bricklayer was surrendered to the control of the architect. Gauged work being reserved for arches, aprons, platt bands, cornices, and pilasters.

There was a significant change in the size and weight of the brick axe, possibly as a response to the concentration of gauged work for enrichments that required large numbers of straight cuts. Cutting soft rubbers with a handsaw rapidly wears its edge, and cut units would have been required quickly and in large numbers in the busy cutting sheds of the period. Contemporary descriptions of the use of the large brick axe, examined through practical testing by the author, reveal that it was used for cleaving the brick to shape by being located in to the incised profile on the rubber cut by the grub saw..

It is likely that some cutters would have also continued to use the smaller brick axe to undertake the fine trimming and shaping, but there was a gradual move to the use of the scotch, which became an increasingly popular tool from this time.

The Victorian and Edwardian periods witnessed great developments and changes in brickmaking, tools, and craft techniques for executing gauged work. The return to favour of fair-faced brickwork after the 1840s, particularly with the emergence of the Arts and Crafts Movement in the 1860s, saw brickwork standards rise again after years of decline. With this movement, and the so-called William and Mary and Queen Anne styles, hand crafting practices enjoyed a revival that in brickwork, led to gauged work rapidly re-establishing itself as the highest form of brickwork for producing architectural dressings on principal facades.

A prolific use of gauged brickwork followed that witnessed a profusion of carved work unprecedented in any former period. This may have been the driving force of many Victorian brickmakers producing fully-washed and screened rubbers to remove unwanted inclusions from their bricks and may also have been partly the reason for producing oversized rubbers, as it helped keep joints within carved enrichments to a minimum. Several larger brick companies, exploiting rail access to the huge markets of London, major towns, and cities, produced their own brand of rubber, such as Fareham Red from Johnson's of Fontley (Hampshire), Ballingdon rubbers from Allen's (Essex), and TLBs from Thomas Lawrence of Bracknell (Berkshire).

One of the greatest changes that revolutionised the speed and accuracy of preparing rubbers for gauged work within the cutting shed, was the introduction of the bow-saw utilising a twisted steel wire blade from the 1870s onwards. Used on clean-bodied and oversized rubbers (which was also beneficial to this cutting technique), and clamped within metal-edged cutting or moulding boxes, the cut surface was finished by abrading the rubbers across the box so as to answer to its profile. This was simply a development of the small bow with straight wire blade, traditionally used by some brickmakers to cut away the surplus cast from the brick moulding box. Twisting the wire serrates it, forming a 360° cutting surface, enabling it to easily follow the intricate curves and changes in direction of architectural mouldings.

The need for a more knowledgeable workforce to embrace technological developments led to major changes in the delivery of apprenticeships from previous periods. Emphasis on education alongside practical tuition at technical colleges to complement on-site learning led to qualifications being attained after a period of five years. City and Guilds syllabi and examination papers of the period reveal the prominence in all areas of study that gauged work was given. As the premier branch of the craft of bricklaying it

was promoted for the very best of apprentices to aspire to and learn, enabling them to work confidently and with pride, alongside their masters on the fashionable highly decorative brick buildings. This ethos survived, until changing economic and social circumstances that followed the First World War (1914-18).

The loss of many of the nation's finest craftsmen in the First World War (1914-18), the decline of the 'upstairs-downstairs' society, and technological advancement of building materials and applications, all contributed to changes in the structural and architectural use of brickwork. Though traditional materials continued to be used it was usually with different applications and in conjunction with new materials, such as, plastics, rubber, aluminium, and steel. Cement rapidly became the principal binder within mortars and concretes. These materials were produced in part, or whole, in highly automated factories, their individual properties being better understood and their performances under loading and climate calculated, so no more than necessary was used.

This movement led to a direct loss of associated crafting skills as gauged work was to be less called for as the years passed, and with it a rapid decline of brickyards making rubbers. Yet it remained an important part of the measure of a first-rate bricklayer, and its use was not infrequent throughout the years until the Second World War (1939-45).

Subsequently there was a pressing need to re-build-bombed cities and towns to provide homes for a rapidly growing population. This made increased use of changing construction technology that was quick, cheap and required less skill, such as the use of thin sectioned cavity walled masonry, of machine-made bricks laid in plain stretcher bond with modern cement based mortar. Suited to the speed of delivery demanded, this became the death-knell for the more refined and skilled areas of bricklaying such as gauged work, again reflected in the continuing loss of traditional brickyards with their own unique type of rubber, as the market for their product collapsed.

Bricklaying, especially from the 1950s, had undergone a significant change from traditional crafting skills to those of assembly or fixing on functional buildings of plain brickwork. This led to a reduction in the apprenticeship period, from five down to three years and the removal from the City and Guilds syllabi of the more advanced areas of craft skills and knowledge, including most references to gauged work. Thomas Lawrence of Bracknell (Berkshire), who made the TLB rubbers, ceased trading in 1984, seriously reducing the palette of colours, textures, cutting, and carving quality formerly available.

Through the publication of *Gauged Brickwork: A Technical Handbook* in 1990, the author strove to return to national prominence this neglected branch of the craft. In his lectures, master-classes and published work, he emphasised the pressing need to revive its skills and knowledge for apprentices, and established craftsmen denied the opportunity to learn. This initiative saw the need to provide a combination of both traditional and modern craft skills and knowledge, through an holistic approach to craft education and skills training to produce fully rounded craftsmen, consolidated by his two-volumed work *Brickwork: History, Technology and Practice* published in 1994.

As Head of Trowel Trades at Bedford College of Higher Education between 1987-92, the author pioneered a broadening of the curriculum for apprentice bricklayers. This was justified by embracing traditional craft skills that had brief references to them within the City and Guilds craft syllabus, were not being taught nationally, as deemed irrelevant to modern site demands. By careful planning of the curriculum this was achieved without compromising the essential elements within the City and Guild syllabus, equipping the apprentice for modern site work and their examinations that led to their qualification. Gauged brickwork clearly stimulated the more able apprentices providing an opportunity to learn the deeper applications of geometry and setting out, as well as traditional materials, and tools for shaping, cutting and rubbing, to construct gauged enrichments. This approach proved to be very popular with the apprentices, who experienced the true essence of brick craftsmanship, in creating from oversized rubbers, an accurate enrichment of finely laid gauged work; subsequently their pride in the craft of bricklaying was significantly raised.

This move was also well received by other associated bodies for a variety of reasons. Employers benefited from more knowledgeable and skilful bricklayers whose work reflected well on them both. Manufacturers of rubbing bricks, frustrated with the generally poor standard of finished gauged work where their bricks were employed were pleased to see the positive capabilities of their rubbers. It also raised national awareness amongst professionals, craftsmen and associated heritage bodies, of the need for knowledge and the skills of gauged brickwork to be taught correctly to help establish standards of work that were acceptable on site.

Unfortunately this period coincided with demise of traditional time-served apprenticeships bound to a qualified bricklayers within a company, for government backed advent of short, competence-based, modular training. This was based on a

system of National Vocational Qualifications (NVQs) which could not facilitate gauged brickwork, due to its emphasis on only an elementary theoretical and technological understanding of the principles underlying the trade, and of basic trowel skills to achieve minimum levels of competence. This system of training is tailored solely to produce bricklayers with a narrow range of basic skills to meet modern site requirements, the needs of the powerful house-building sector, and the demands of accountants, dictating practices, beyond their qualifications and understanding, in order to deliver at minimal cost.

At the time of writing (2004), discerning clients are increasingly requesting gauged enrichments for their new prestigious brick properties, and ever-greater numbers of our historic buildings need repair and restoration to gauged work. Bricklayers wishing to become engaged in gauged brickwork discover that the modern NVQ system of training does not cater for it and that colleges and other training organisations offering conservation programmes only give a rudimentary introduction to the subject of gauged work. Few tutors in these environments have practical site experience, or a full technical knowledge of the subject. Such courses fail to provide the depth that is vital to gain a meaningful understanding of gauged work, its historical development and context, and the importance paid to it in the past.

Today, only a few brickmakers continue to provide rubbing bricks for gauged work. This loss has had an effect on the variety of rubbers cutters that are now available for the repair and restoration of historic buildings. The contraction in the manufacture of rubbers has also seen a steep increase in their costs to levels that are of concern to all involved with traditional brickwork and its conservation. Whilst rubbing bricks always commanded higher prices than standard bricks (typically 50-150% more), the current cost differential is several times greater. This needs to be addressed as it has an obvious effect on project costs as colleges, or other training establishments, cannot include gauged work as part of their curricula within their limited budgets. This reduces training opportunities and exacerbates a long-term contraction in the skills necessary for the repair and restoration of historic brick buildings.

The move by some brick companies towards using machines for cutting ashlar and voussoir units, and to abrade mouldings to shape for on-site assembly only, has led to the production of harder rubbers, which withstand the use of a cutting disc or profiled caborundum wheel. Softer rubbers cause excessive wear and in machining can lose their all-important sharp arrises. The production of machine-cut gauged enrichments

satisfies the modern demand for on-site fixing of quality-controlled units, removing the need for cutting shops and highly skilled labour to prepare, set out, and cut the rubbers. This, however, has led to the rapid loss of traditional craft skills and the knowledge necessary to set out and work the rubbers. Furthermore, and especially in restoration work, there is nearly always the need to hand-finish rubbers to match the facing techniques of the surrounding original work. Mechanised work, or gauged work by extrusion, looks devoid of a craftsman's touch and can appear dead in its lack of tooling and abrading styles. Similarly, modern purpose-made gauged units do not always follow the varying styles of the period, particularly gauged flat or camber arches, which are often set out and bonded to a standard format. Such practices are of particular concern, as the skills of the brickmaker are clearly not those of the qualified bricklayer with experience of working with gauged work.

Combine this with the frequent lack of consistency in colour and texture when matching modern washed rubbers to old, and the character and charm of quality Stuart, Georgian, or some Victorian brickwork can be readily lost.

It is entirely understandable and correct that smaller brick companies will seek to increase productivity and the service they offer to survive in today's competitive market. That, in doing so, some will adapt and produce rubbers that are better suited to their own particular in-house cutting and moulding techniques for supplying pre-cut enrichments is inevitable. We must, however, retain a balance and not lose sight of the variety of soft-textured rubbing bricks that can be produced, albeit in a small way. It is also important that ranges of authentic rubbers are readily available for the craftsmen and women involved in bespoke repair and restoration work on buildings of various periods; similarly for use by enthusiastic bricklayers who wish to learn and become conversant with the traditional crafting skills of gauged brickwork. Finally, and of equal importance, rubbers should be sold at a price that provides a sensible return to the brickmaker, but that builder and discerning client can sensibly afford.

The growing practice over recent years, and one that is also seen and commented on in the other crafts, for unqualified persons supplying building products to give advice on the causes of failure and the repair and restoration of brickwork is of concern. With regard to highly skilled gauged brickwork, it is all the more serious.

Changes in fashion and architectural practices, often associated with a desire for speed and economy, meant that potential bricklayers/craftsmen were forced to make do with

crash courses and other limited tuition. This, coupled with a severe building slump in the 1990s, was almost a disaster for all building trades.

Today we stand at a crossroads. If we truly want to see craftsmanship in brick, whether restoring old buildings or constructing new ones, we must provide a much broader base of knowledge in the subject than has been more recently available. The present trends in apprenticeship training indicate that sadly this will not be so. With an emphasis being mainly on 'fixing' skills for modern house building, these are woefully inadequate for the full range of skills necessary for a true craftsman able to work with confidence in all areas of his craft.

Modern technical books and training programmes for bricklayers, and designers, rarely elucidate on traditional techniques and this information is being lost from the craft at a time when conservation and restoration needs increasingly demand such knowledge and practical skills.

A craftsman must acquire a deep understanding of the characteristics of the materials that were and are still used so that he can make sound judgements as to the appropriateness of their correct use in a given situation. Craft skills must be based on the best of traditional practices and executed with subtlety of touch. He must gain an understanding of how and why his ancestors worked in the way they did as well as ensuring that his work today is in harmony with current practices and regulations.

The preparation, setting out, and construction of a gauged niche masterpiece were undertaken to demonstrate the highest level of crafting skill and deep understanding of the geometry required to produce work that was, historically, considered the supreme test of a craftsman.

The information and skills gained from this exercise will prove invaluable to the author when promoting the history, materials, tools and equipment, skills, and knowledge of gauged work. It will also be of value in encouraging best practice in the conservation, repair, and restoration of historic brickwork through lectures, masterclasses, individual tuition, and publications, and in the repositioning of gauged work within formal training programmes.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 *Conclusions*

It is self-evident that the knowledge and skills of working bricks in their post-fired state have had a long and significant history in England. From the direct influence of the immigrant Flemish masons/bricklayers (acknowledged masters in crafting their bricks as if they were stones), native craftsmen absorbed the skills and explored the possibilities of cut and rubbed work to wonderful architectural effect from the fifteenth century.

During the seventeenth century, and particularly after the Interregnum, these skills were refined to the highest levels and displayed as gauged brickwork; directly influenced, once again, by the best brickmaking and bricklaying practices of the masters in the Netherlands and, in particular, the wealthy province of Holland. Gauged work, of colour-matched soft textured bricks, set with great accuracy in fine lime putty: silver sand joints, became the finest expression of brickwork entirely suited to the new architectural fashion of the period. After a term of decline, from the late Georgian period, there was an important return to the use of ornamental and very accurate gauged work in the second half of the nineteenth century, as the fashion for associated architectural revival styles predominated.

The widespread reserves of high silica-bearing brickearths and top clays in England, particularly in the south of the country, provided the necessary raw material for bricks capable of being cut, carved, and abraded, without detriment, for both cut and rubbed and gauged brickwork. Such bricks became known as rubbing bricks, rubbers, or cutters. Contemporary brickmaking practice, particularly firing to temperatures between 800 and 950°C, had the effect of not only providing bricks 'soft' enough for working to size and shape, but also to render the silica reactive. Hence, an all-important protective case-hardening was initiated once the porous rubber was dampened immediately prior to the setting phase of construction.

The traditional brickyards of today no longer exploit the brickearths and top clays with naturally high silica content, and none carry on the practice of low firing. This is regrettable, as the bricks they produce are such an important part of our architectural

heritage. The desire to produce rubbing bricks in the manner of the, now defunct, brickyards that survived from the nineteenth century has led to an over-concentration on the washed, clean clay, late Victorian type of red rubber. This is at the expense of the handpicked rubber, selected out of a general firing that could include units of various tones, textures, and inclusions.

The comparison of historic and contemporary rubbing bricks has shown that their main distinction arises from differing firing temperatures. The historic rubbing bricks have significantly greater porosity than their modern counterparts, due to lower firing temperatures. This enhanced porosity has led to a more efficient water transport system within the matrix, aiding the widespread crystallisation of cements from solution.

To survive in the modern competitive market brick companies will naturally seek to increase productivity and the range of products and services they offer. Some of the smaller traditional brickmaking companies will produce rubbers that are better suited to their own particular in-house cutting and moulding techniques. We must, however, retain a balance and not lose sight of the variety of soft-textured rubbing bricks that can be produced – albeit in a small, even seasonal way – so that we have a product that is wholly appropriate for the repair and conservation of historic buildings. At present the cost of rubbing bricks is prohibitively expensive, and should be addressed so that a fair return is seen for the brick company, yet does not impact on project costs or on colleges or training centres wishing to include gauged work in their curricula.

The advent of unqualified persons from companies supplying building products giving advice on the repair and restoration of brickwork raises serious concerns in regard to gauged brickwork. This, being the highest branch of bricklaying requires superior craft skill, knowledge, and experience. Those advising must be imbued with these attributes, professionally they must be qualified and possess an empathetic understanding of all that was involved in this aspect of work, so that correct assessments are made and appropriate advice given.

Through the skilled use of brick axes, handsaws, scotches, files, rasps, chisels, and hand-held rubbing stones, along with templets and trammels, craftsmen bricklayers crafted work of great accuracy and beauty. We have much to learn and re-learn about the tools, equipment, materials, and craft techniques of the hewers and setters who produced cut and rubbed and gauged work in the different historic periods. It is important to have a broad experience and understanding of the influences of historical

materials, tools and techniques that created the aesthetics of the post-fired brickwork of the differing historical periods. This would serve to ensure that the best of these influences could be employed judiciously in restoration and conservation and where appropriate on new work.

The continuing lack of time-served and well-educated bricklaying apprentices coming in to the craft to safeguard its long-term future, as opposed to the emphasis on trainees on short, modular-based programmes of limited academic content, will ultimately lead to a crisis in the craft. Gauged brickwork was always reserved for deep-thinking, intuitive and patient craftsmen who excelled well beyond the trowel skills of standard bricklayers. There can be no shortcuts to learning properly the highly skilled branches of any craft, and any that are taken will always be exposed sooner rather than later.

Many bricklayers will be called on, at some point in their career, to undertake work on the fabric of traditionally constructed buildings, some of which may be of immense historic significance, with fine quality gauged brickwork enrichments. Few under prevailing conditions, will be qualified to do so, lacking the refined craft skills or technological and theoretical knowledge necessary to underpin and execute the first-class work they are to match. An issue every bit as serious, yet continually ignored, not only for bricklayers, but for those who survey and specify the work, is that few will have any understanding of the historic framework of the masonry. This omission is revealed in the all too familiar inappropriate approaches of materials and craft techniques employed, which result in much historically significant work being irreversibly damaged.

Gauged work needs to be introduced, at a basic level, in to the existing NVQ bricklaying-training scheme. The more able student, regardless of age, can successfully advance upon that foundation to higher levels of the craft and gain certification in the various defined competencies of cut and rubbed, and gauged brickwork. This can lead on to all aspects of its repair, conservation, and restoration. This, with careful planning, would be a positive contribution towards reviving and promoting the skills and knowledge of gauged brickwork within the craft, and help in the drive towards securing work of a higher quality on new build and historic brick fabric.

Through master classes, seminars, and targeted publications, one could promote a wider understanding of cut and rubbed, and gauged brickwork, not only within the craft of bricklaying, but also within associated professional bodies and the general conservation industry. This approach would secure this very special area of the craft for

the future, preventing its loss and the negative implications for the repair, conservation, and restoration of historic brick properties.

7.2 Recommendations

Whilst the conclusions drawn from this thesis are limited to the research undertaken, it is possible to make recommendations at two broad levels – further research in relation to the history and development of English gauged brickwork and further action to secure the craft base of those responsible for the repair, conservation, and restoration of gauged brickwork.

Recommendations for further study of English gauged brickwork are:

1. Initiate further research in to the skill levels of the medieval and Tudor hewers, including detailed examination of fifteenth- and sixteenth-century cut and rubbed work, to find evidence of Flemish practices using the *steenschaaf* for *in situ* finishing of enrichments.
2. Continue research in to the very early gauged work at Houghton House in Ampthill (Bedfordshire), to confirm its date of the 1620s and possible authorship by Nicholas Stone, rather than Inigo Jones. This would place the work significantly ahead of Kew Palace (1631), which is often given as the building in which gauged brickwork was first introduced in to England.
3. Examine further relevant post-Restoration documents to determine if Dutch bricklayers can be found to have worked on projects involving gauged brickwork enrichments.
4. Expand our knowledge of the city master bricklayer Edward Helder, particularly his birthplace and family history, to confirm whether there is a connection with the Netherlands.
5. Ensure that the significance of the gauged brickwork masterpiece of Edward Helder, located in the Victoria and Albert Museum, is fully recognised by all stakeholders and conservation bodies. This also applies to the enriched brickwork that was relocated to Christ's Hospital School in Sussex and to the entrance doorways for the barristers' chambers of King's Bench Walk in London (both examples possibly by Helder).
6. Further research in to the skill levels of the early seventeenth-century English master bricklayers to determine the extent of their stonemasonry skills, and how

they would have assimilated the definitive and refined skills of gauged brickwork of the Amsterdam bricklayers.

7. Identify and initiate detailed examination of all seventeenth- and early eighteenth-century gauged niches in England, in order to record their styles, measurements, setting out, and constructional techniques, and determine whether they followed a common craft practice.
8. Undertake archival research to learn more about the major building companies, and the names of their master bricklayers, who carried out exemplary gauged brickwork in London. This includes the ornate brickwork of the Metropolitan Board of Works estate of Chelsea Embankment, Tite Street, and Cadogan, and Hans Place Estates of Cadogan Square and Pont Street.

With regard to the conservation and repair of historic decorative brickwork, it is recommended that further action be taken in relation to the following points:

1. Promote the production of a wider range of low-fired soft rubbing bricks using traditional methods to achieve a consistent quality of rubber to be used successfully in matching brickwork of all periods and regions.
2. Encourage rubbing-brick producers to consider firing at lower temperatures in order to create a rubbing brick that is easier to cut and rub, has higher porosity, and hence is more compatible with its historic counterpart.
3. Discuss how the cost differential of rubbers over standard bricks can be reduced so that that they can be utilised more widely.
4. Raise awareness of the limitations inherent within current craft-training programmes, and the lack of teaching of high-level skills for bricklayers, with training and heritage bodies. This is particularly important in relation to gauged brickwork and its conservation and restoration on historic buildings.
5. Seek the re-introduction of a structured time-served apprenticeship to encourage the holistic dissemination of knowledge about traditional and modern craft practices. This could be achieved, at the higher level, through masterclasses, seminars, and publications.
6. Introduce, at an appropriate level in the existing NVQ training scheme, a foundation upon which the more able student can advance successfully to the higher levels of the craft and gain certification in competencies including gauged brickwork skills.
7. Raise the level of vocational qualifications available to advanced bricklaying students to that equating to degree level for those wishing to learn the finer traditional skills of the craft including gauged brickwork.

8. Promote a wider understanding of cut and rubbed, and gauged brickwork within the craft of bricklaying, associated professional bodies, and the general conservation industry, in order to encourage high-quality new build, and the successful repair, conservation, and restoration on historic buildings and structures.
9. Continue the investigation of cutting and shaping tools available to the historic brick-cutter in preparing mouldings for gauged brickwork, and re-create gauged work by using the same skills and techniques alongside the better-known techniques of the nineteenth century.
10. Undertake further research to determine differences between historic and contemporary rubbing bricks, particularly the physical properties relating to workability and durability.
11. Promote a wider public understanding of traditional brick-built properties through the selective use of the media, linking historical development to craft demonstrations, and emphasising the use of correct materials, craft tools, and practices, so highlighting quality skills such as gauged brickwork.

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APPENDICES

Appendix 1: List of activities relating to cut and rubbed, and gauged work undertaken by the author during the period of this PhD.

Over the period of this research, the author has undertaken many activities in his professional capacities that have helped raise awareness of gauged brickwork at many levels.

Consultancy

Date	Type	Project	Brief	For
16/02/04	Consultancy	Hampton Court Palace, London	To design and recreate an improved cut and rubbed moulding for one of the chimneystacks of the Great Gatehouse.	Hampton Court Palace, London
27/11/03	Consultancy	Stutton Hall, Stutton, Suffolk	Advice and report on condition of sixteenth century walled garden including cut and rubbed dressings	Wincer Kievenaar Partnership
19/11/03	Consultancy	St Mary's Church Tower Winkfield, Berkshire	Site meeting with prospective contractor to look at restorative techniques to be employed on all aspects of above	St Mary's Parish Church Committee
04/11/03	Consultancy	St Mary's Church Tower Winkfield, Berkshire	Specification for restoration of brickwork including cut and rubbed dressings	St Mary's Parish Church Committee
13/10/03	Consultancy	Jigginstown House, Naas, County Kildare, Eire	Further on-site advice on original materials, techniques used for the cut and rubbed dressings of the early seventeenth century property - 2 days	DUCHAS, Eire
28/07/03	Consultancy	Jigginstown House, Naas, County Kildare, Eire	On-site advice on original materials, techniques used for the cut and rubbed dressings of the early seventeenth century property	DUCHAS, Eire
21/07/03	Consultancy	St Mary's Church Tower Winkfield, Berkshire	General appreciation of the seventeenth century brick construction and condition including cut and rubbed dressings	The Brick Development Association
01/02/03	Consultancy	Warfield House	To date - monitoring and reporting on conservative restoration to historic brickwork including gauged brickwork	Willes Simpson Wood, Chartered Building Surveyors
01/02/03	Consultancy	RICS Post Graduate Diploma	Marking a dissertation on gauged brickwork	College of Estate Management

Date	Type	Project	Brief	For
14/01/03	Consultancy	Kirby Muxloe Castle, Leicestershire	On-Site advice relating to conservative repair of historic brickwork including cut and rubbed mouldings	English Heritage
12/12/02	Consultancy	31 Tite Street, London	On-site advice regarding previous cleaning and possible repairs to gauged brickwork	Private Individual
21/10/02	Consultancy	Hampton Court Palace, London	General overview of gauged brickwork	Hampton Court Palace
20/08/02	Consultancy	Historic St Mary's City, Maryland, USA	Advice relating to history of colonial brickwork in particular materials and techniques necessary for the rebuilding of St Mary's Church, including cut and rubbed dressings - 5 days	Mesick, Baker, Cohen and Wilson, Architects, New York
25/07/02	Consultancy, Report on condition Specification	Warfield House, Berkshire	Site Survey of eighteenth century mansion for assessment of fabric including gauged dressings	Willes Simpson Wood, Chartered Building Surveyors
06/05/02	Consultancy	New Kings Road, London	On-site advice for conservative repair of gauged arches	Private Individual
18/04/02	Consultancy	Eltham orangery niche, London	Advice on the conservative restoration	Caroe & Partners
19/03/02	Consultancy	Gauged facade, Pewsey, Wiltshire	On-site advice in relation to an eighteenth century tuck pointed gauged façade	Private Individual
17/12/01	Consultancy	Harrods, Knightsbridge, London	On-site advice to determine reason for problems with gauged arch construction	Skanska Construction Ltd
30/04/01	Consultancy	Geffrye/ Bradmore niche, London	On-site advice to craftsmen and brickmaker	Geffrye Museum
06/03/01	Consultancy	Geffrye/ Bradmore niche, London	On-site advice on extent of damage and proposals for conservative restoration	Geffrye Museum
23/01/01	Consultancy	Ravensdale Mansions	Specification - repair of gauged brickwork	Cameron Durley Consulting
22/01/01	Consultancy	National Westminster Bank, Harrow	On-site advice repair and restoration of gauged enrichments	Cooch and Associates, Architects
09/01/01	Consultancy	2 John Street, London	On-site advice repair of gauged arches	Harding and Associates, Chartered Surveyors

Lectures

Date	Type	Project	Subject	Audience
1/03/03	Lecture/Master Class	American Lime Conference, Virginia, USA	Seventeenth century Red Mason lecture and cutting and rubbing brickwork master class - 3 days	Virginia Lime Works, Virginia, USA
08/01/03	Lecture/Training	Historic St Mary's City, Maryland USA	Training for two craftsmen relating to techniques necessary for the rebuilding of Historic St Mary's Church cut and rubbed dressings - 5 days	Virginia Lime Works, Virginia, USA
22/10/02	Lecture/Training	SPAB Scholars	General overview of cut and rubbed and gauged brickwork - 2 days	The Society for the Protection of Ancient Buildings
12/10/02	Lecture	MSc in Conservation	Historical Development of English Gauged Work	Cambridge Historic Buildings Group, Cambridge University
27/09/02	Lecture	-	Historical Development of English Gauged Work	Institute of Historic Building Conservation,
05/09/02	Lecture (Gerard Lynch, David Watt and Belinda Colston)	Construction and Building Research conference	Presentation of paper - The Character and Use of Modern Rubbing Bricks in the Conservation of Historic Gauged brickwork	Construction and Building Research Conference
16/03/02	Lecture	Chesterton Gauged Brick Gateway, Warwickshire	History and Restoration of the Seventeenth Century Gateway	The British Brick Society
27/03/01	Lecture	-	English Gauged Brickwork - a historical overview	The Georgian Group

PhD Activities

Date	Type	Project	Subject	With
20/04/04	Meeting	Niche construction	Design of hood mould support	Historic Brickwork Restoration Contractor
10/03/04	Meeting	Niche construction	Design of building platform	Historic Brickwork Restoration Contractor
13/02/04	Meeting	Niche construction	Finalise CAD drawings for niche masterpiece	Architect
13/02/04	Meeting	Niche construction	To determine the equipment to be made to build gauged brick niche masterpiece	Historic Brickwork Restoration Contractor
21/11/03	Training	St Mary's City, Maryland USA	Training for a craftsman in relation to cut and rubbed brickwork - 5 days	Quinque, USA/ Historic Scotland
10/09/03	Training	Niche construction	Clarification of geometry used to describe niche hood on section in order to develop working templets	Architect
31/05/03	Meeting	Niche construction	To detail hood mould to build hood of niche exemplar over	Historic Brickwork Restoration Contractor
26/04/03	Training	Niche construction	To date - The Prince of Wales's Craft Scholarship for a trainee in setting out, cutting, geometry and building of gauged brickwork niche.	The Prince's Foundation
15/03/03	Meeting	Niche Construction	Preliminary viewing of CAD drawings of Niche	Architect
26/02/03	Meeting	Niche construction	To detail reducing box for hood voussoirs to niche masterpiece	Historic Brickwork Restoration Contractor
14/02/03	Meeting	Niche construction	Instruction in respect of details for niche masterpiece to be drawn by CAD.	Architect
11/01/03	Site Visits	Historic St Mary's City, Maryland USA	Conducted tour for two architects and craftsmen of several important historic brick buildings to indicate cut and rubbed enrichments	Mesick, Baker, Cohen and Wilson, Architects, New York and Virginia Lime Works, Virginia, USA
20/10/02	Meeting	Niche construction	To detail cutting boxes to be made from templets for niche exemplar	Historic Brickwork Restoration Contractor

PhD Courses

Date	Course Title
16/06/03	Writing skills for research students
11/06/03	Winning grant funding
12/05/03	Finishing your thesis and preparing for your viva
27/02/02	Starting your research
27/02/02	Planning and managing your research
28/01/02	Writing for publication
05/04/01	Induction event for research students

Training

Date	Type	Project	Brief	Client
15/03/04	Training with lecture/s	Weald and Downland Open Air Museum	Introduction to Gauged Brickwork - 3 day course	Craftsmen and professionals associated with traditionally constructed brickwork
22/07/03	Training with lecture	SPAB Scholars	Basic Introduction to Cut and Rubbed and Gauged Brickwork	The Society for the Protection of Ancient Buildings
02/07/03	Training	-	Cutting gauged work	Individual bricklayer
23/06/03	Training with lecture	Weald and Downland Open Air Museum	Advanced Gauged Brickwork, Camber Arch construction- 3 day course	Craftsmen and professionals associated with traditionally constructed brickwork
10/06/03	Training	New Kings Road, London	Gauged Flat Arch Setting out and Construction - 1 day	Individual bricklayer
14/04/03	Training	National Trust	Training for Mr David Watts, Derby and his apprentice Mr Tom Saunders - Introduction to Gauged Brickwork/Cutting	National Trust, Derbyshire
10/03/03	Training and lecture	Weald and Downland Open Air Museum, Sussex	Introduction to Gauged Brickwork - 3 day course	Craftsmen and professionals associated with traditionally constructed brickwork
17/06/02	Training and lecture	Weald and Downland Open Air Museum, Sussex	Advanced Gauged Brickwork - 3 day course	Craftsmen and professionals associated with traditionally constructed brickwork
20/05/02	Training	Eltham Orangery, London	Bespoke training for Miss Emma Simpson relating to restoration of Eltham Orangery niche	Nimbus Construction Ltd
15/04/02	Training and lecture	Weald and Downland Open Air Museum, Sussex	Introduction to Gauged Brickwork - 3 day course	Craftsmen and professionals associated with traditionally constructed brickwork
11/10/01	Training	Harrods, Knightsbridge, London	Introduction to basic skills of Gauged Brickwork - 1 day course	Skanska Construction Ltd
11/06/01	Training and lecture	Weald and Downland Open Air Museum, Sussex	Introduction to Gauged Brickwork - 3 day course	Craftsmen and professionals associated with traditionally constructed brickwork
27/02/01	Training	Hampton Court Palace, London	To train Miss Emma Simpson in cutting and rubbing of chimney mouldings	Nimbus Construction Ltd
05/02/01	Training and lecture	Weald and Downland Open Air Museum, Sussex	History and repair of gauged brickwork - 1 day course	Craftsmen and professionals associated with traditionally constructed brickwork
16/10/00	Training	Bedford Park	Train on carving gauged brickwork	Individual bricklayer

Publications

Date	Title	Journal
Volume 9 Number 1 March 2003	The Characteristics and Properties of Rubbing Bricks used for Gauged Brickwork, Parts One	The Journal of Architectural Conservation
Volume 9 Number 2 July 2003	The Characteristics and Properties of Rubbing Bricks used for Gauged Brickwork, Parts Two	The Journal of Architectural Conservation
September 2002	The Conservation and Repair of Historic Decorative Brickwork	Proceedings of the Construction and Building Research conference
Date	Title	Publisher
May 1994	Brickwork: History, Technology and Practice Volumes 1 and 2	Donhead Publishing
May 1990	Gauged Brickwork: A Technical Handbook	Gower Technical Press

Appendix 2: Enlarged and annotated figures

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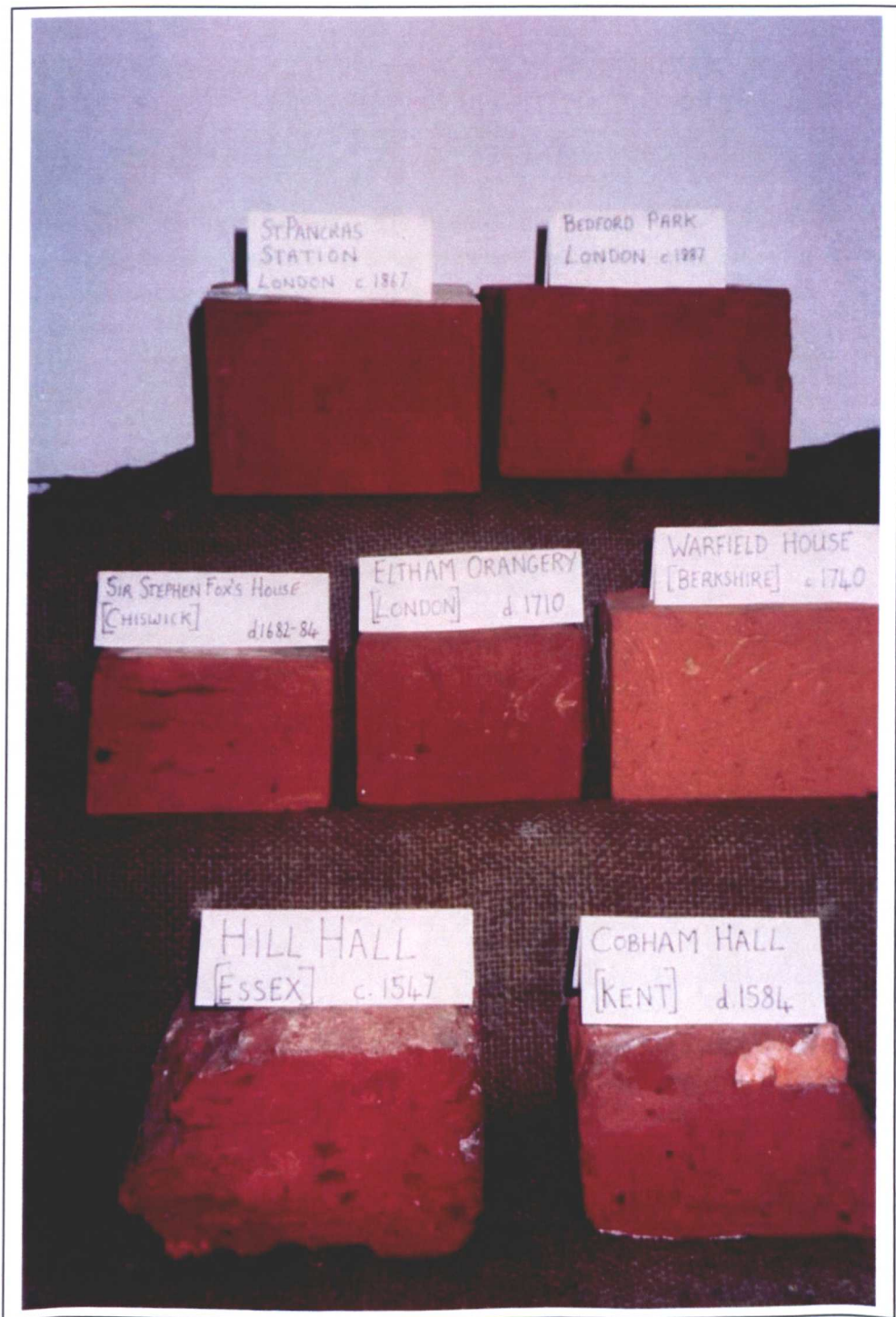
i - (Figure 1) *Decorative herringbone tool markings to cut brickwork in Sienna (Italy) 1090*

The chisel marks work to a central line, inclining left to right at varying angles and spacing.

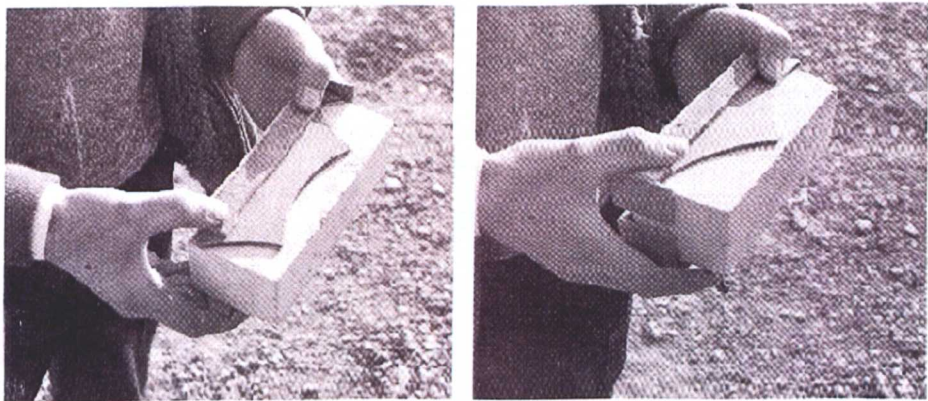


ii - (Figure 3) Sections of historic rubbing bricks from the sixteenth to the nineteenth century.

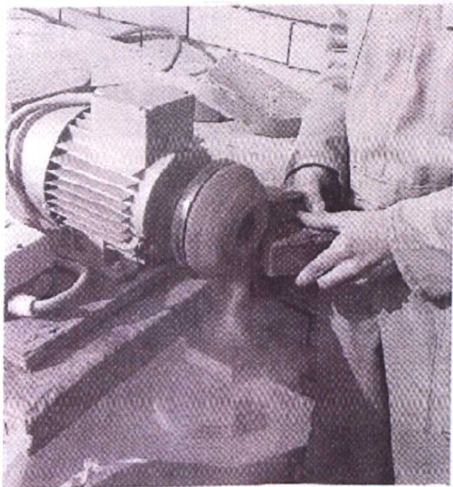
Although from different parts of the south of England and varying in the amount of inclusions within their bodies, the texture, firmness, and cutting and rubbing quality is remarkably similar.



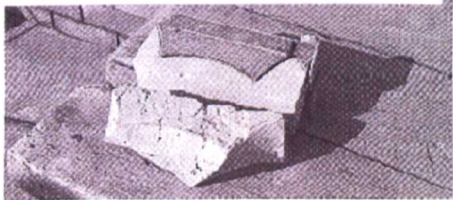
iii (Figure 8) Flemish bricklayers cutting and rubbing moulded bricks for a 'topstuck'.



The two templets are reproduced on the bricks, by the application of clip moulds, one on the top one on the bottom. during working. these two patterns must be brought together to meet



Abrading a brick, during which it is held against an electrically driven grinding stone.



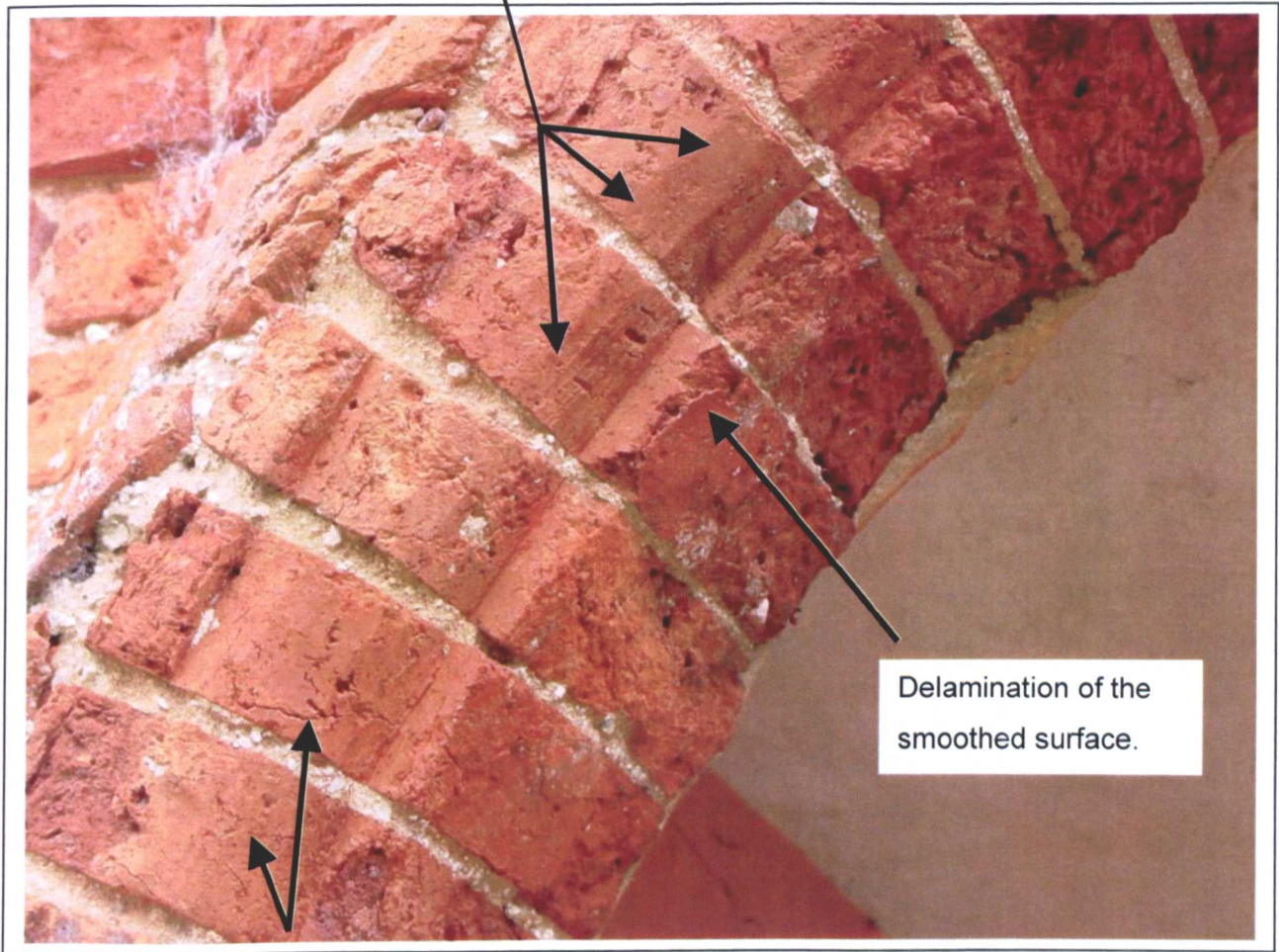
A completed brick in front of the unshaped brick with templet.



A moveable plan mould, which determines the entire profile of each brick course. This is a continuous control during erection of the profiled bricks. It rotates round a centrally placed profile or 'rei' , guaranteeing vertical brickwork.

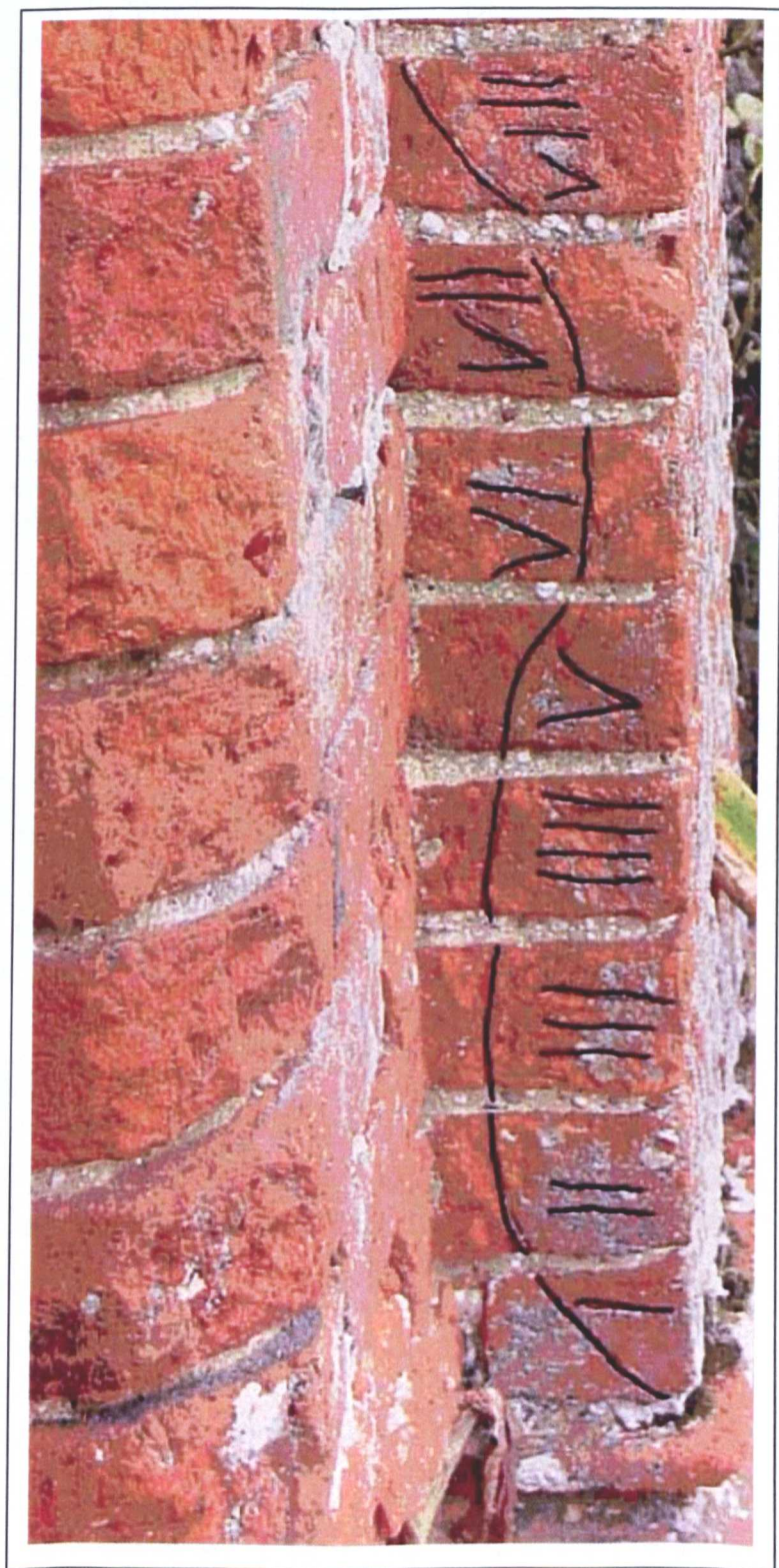
iv (Figure 10) Green-cut moulded voussoirs to the garden gateway, Stutton Hall (Suffolk),
c.1553

The tell-tale smoothing marks, which denote green-cut moulding.

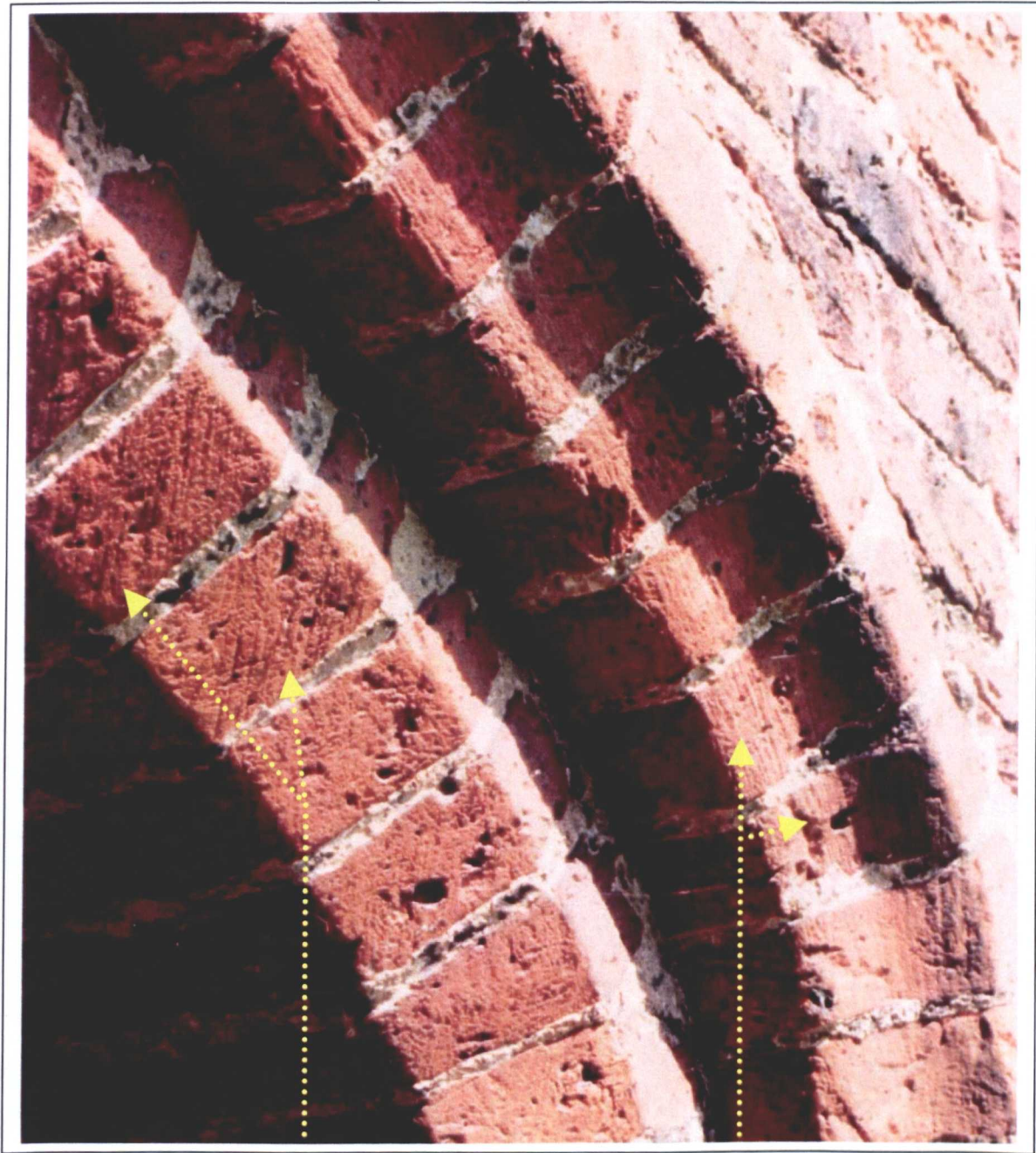


Shrinkage cracks from drying and firing after moulding.

v (Figure11) A green-scribed 'accolade' with Roman numerals for each brick for correct position and to help align a fluted pilaster with entasis on the garden gateway, Stutton Hall (Suffolk), c.1553



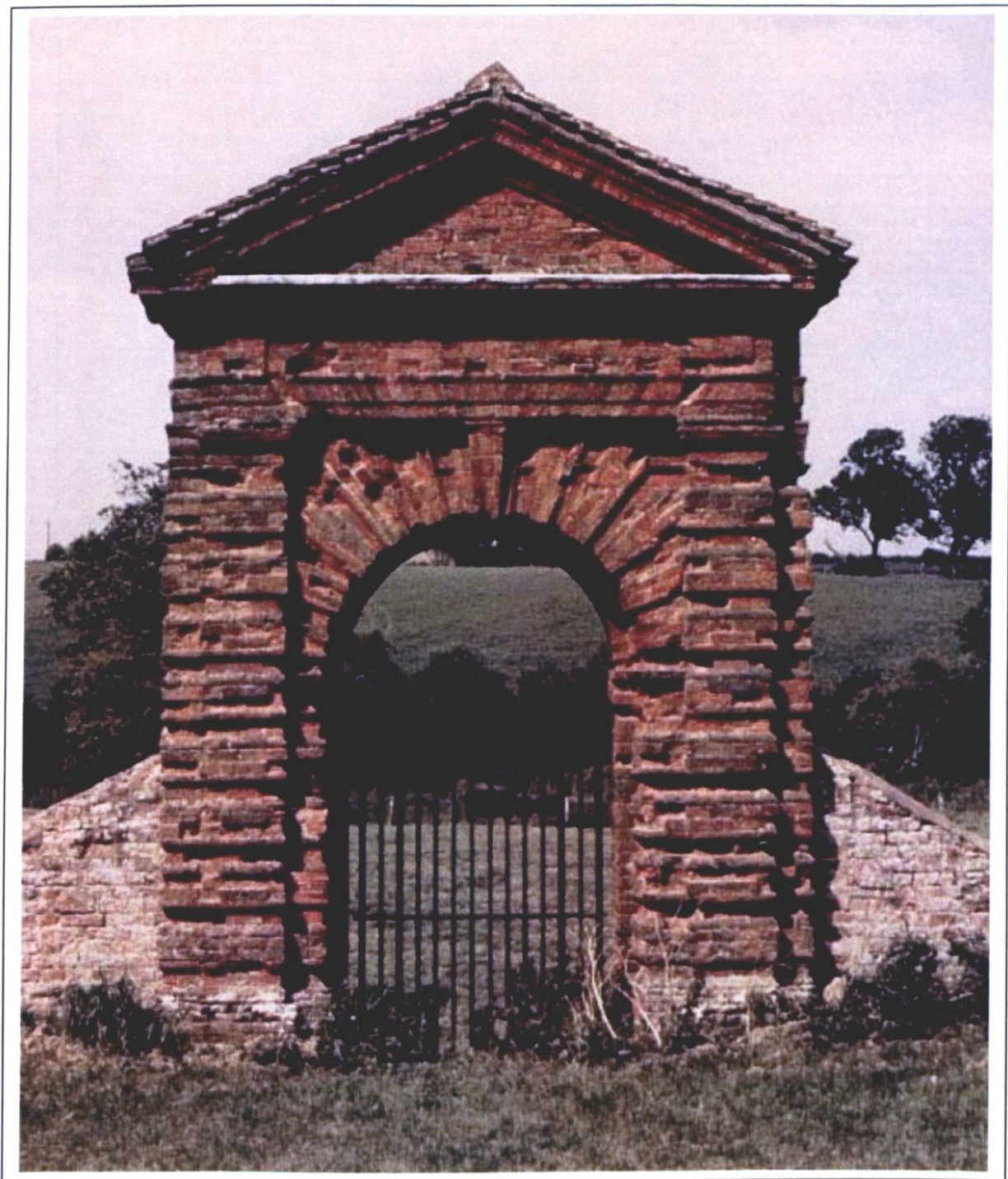
vi (Figure 17) Cut-moulded voussoirs with various styled axing strokes at Kirby Muxloe Castle (Leicestershire), 1483.



Axe strokes diagonal to flat face

Axe strokes parallel to curved face

vii (Figure 26) *The Chesterton gateway (Warwickshire), c. 1662, before restoration in 1987.*



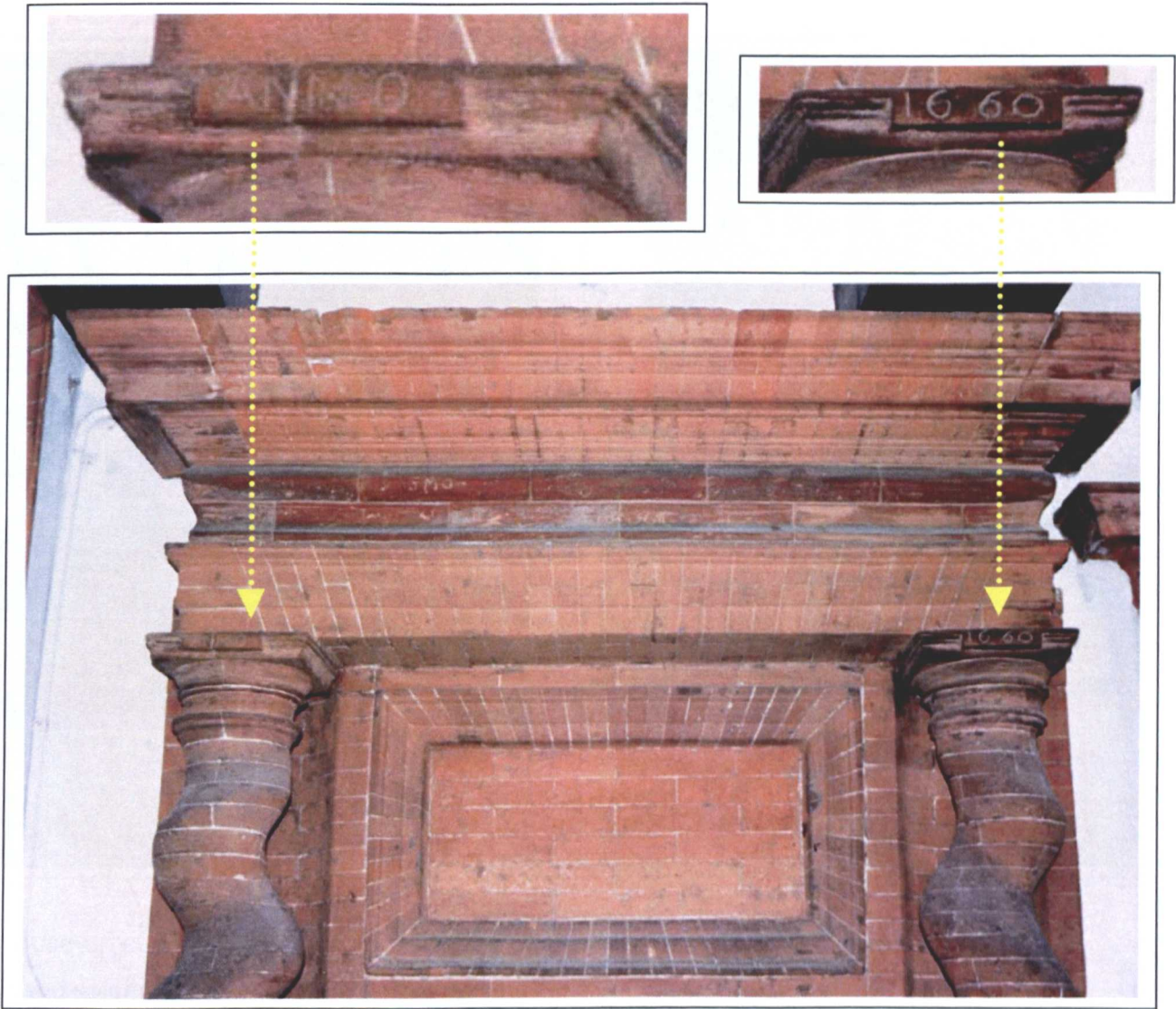
viii (Figure 27) *The Chesterton gateway (Warwickshire), c. 1662, after restoration in 1991.*



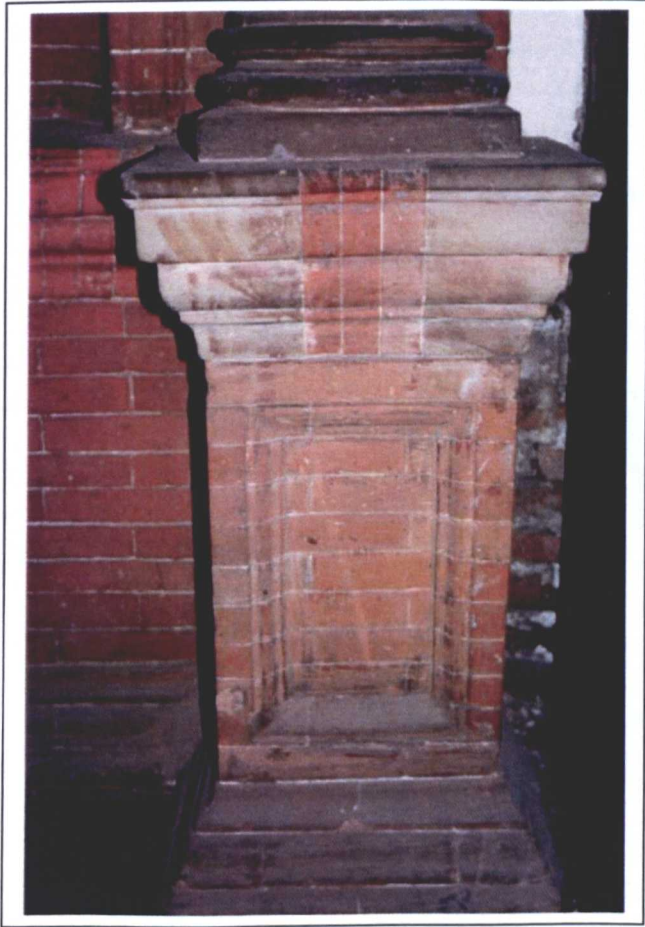
ix (Figure 28) A radial 'Steenschaafed' finish to an arch face. The striations pass in line from voussoir to voussoir, showing this was executed in situ, 64 Breestraats, Leiden, Netherlands, 1635.



x (Figure 31- in sections) Exquisite premier 1660 masterpiece or gildeproven, De Waag, Amsterdam.

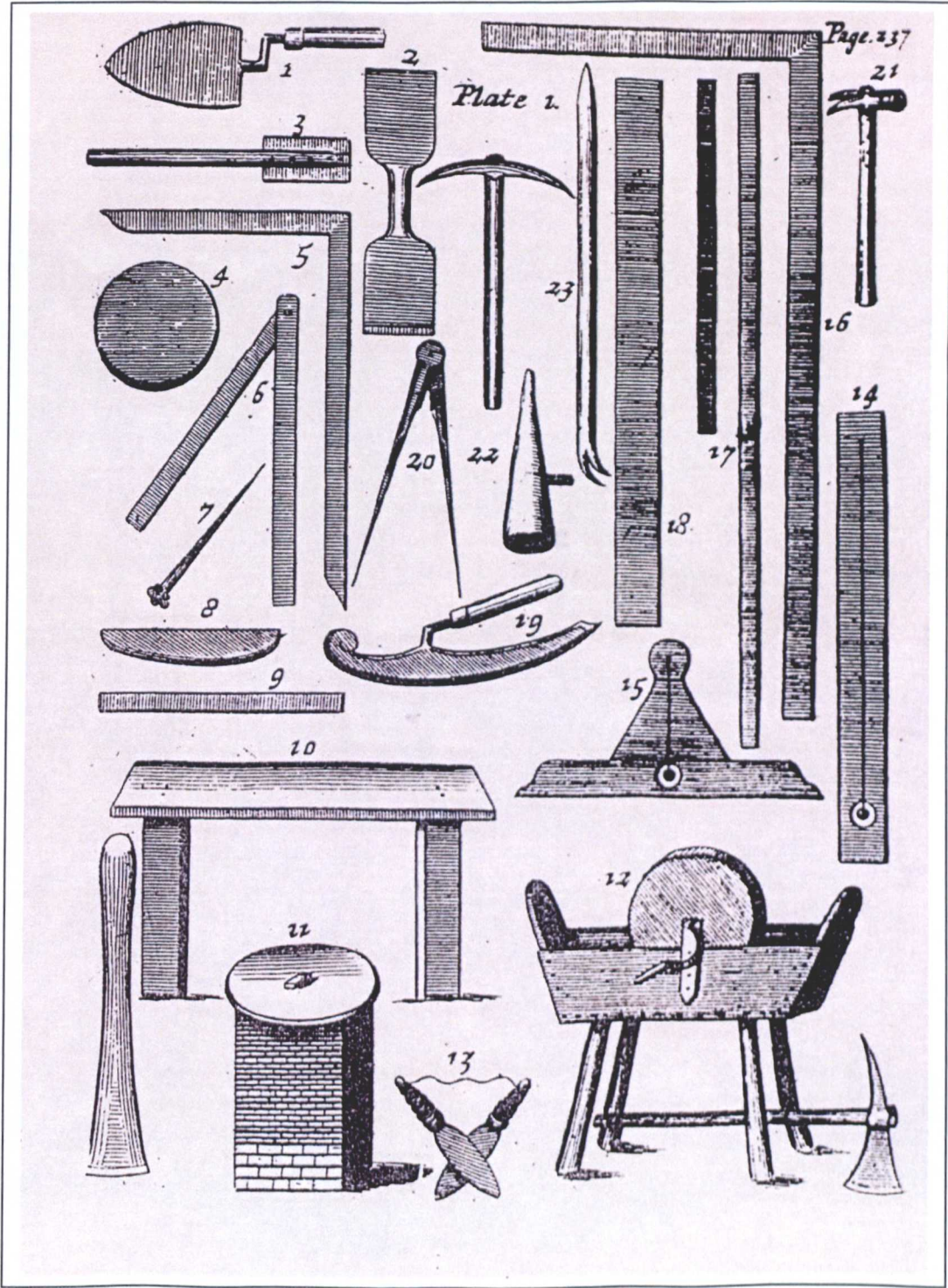


A niche with raised moulded architrave to body and hood with a scallop-shell boss. Note the solomonic columns.



Close-up of a base detail below the right-hand solomonic column, revealing a wealth of cut, gauged mouldings. Interestingly the top course has terminal stonework, whereas the left-hand base has been wholly executed in brick.

xi (Figure 48) Moxon's plate 1 depicting tools used by the seventeenth-century bricklayer.

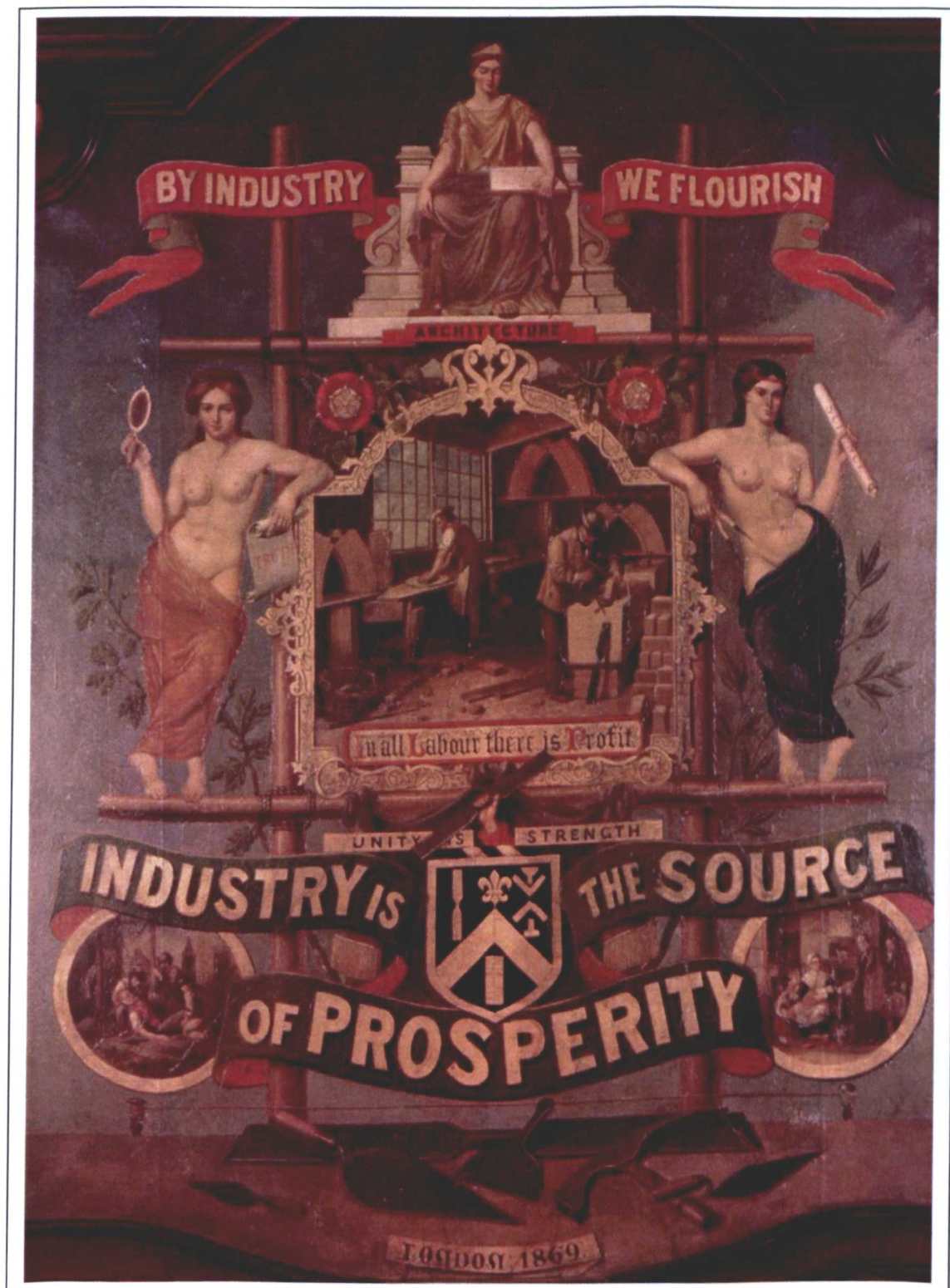


xii (Figure 73) The Operative Society of Bricklayers membership certificate by A.J. Waudby, 1863.



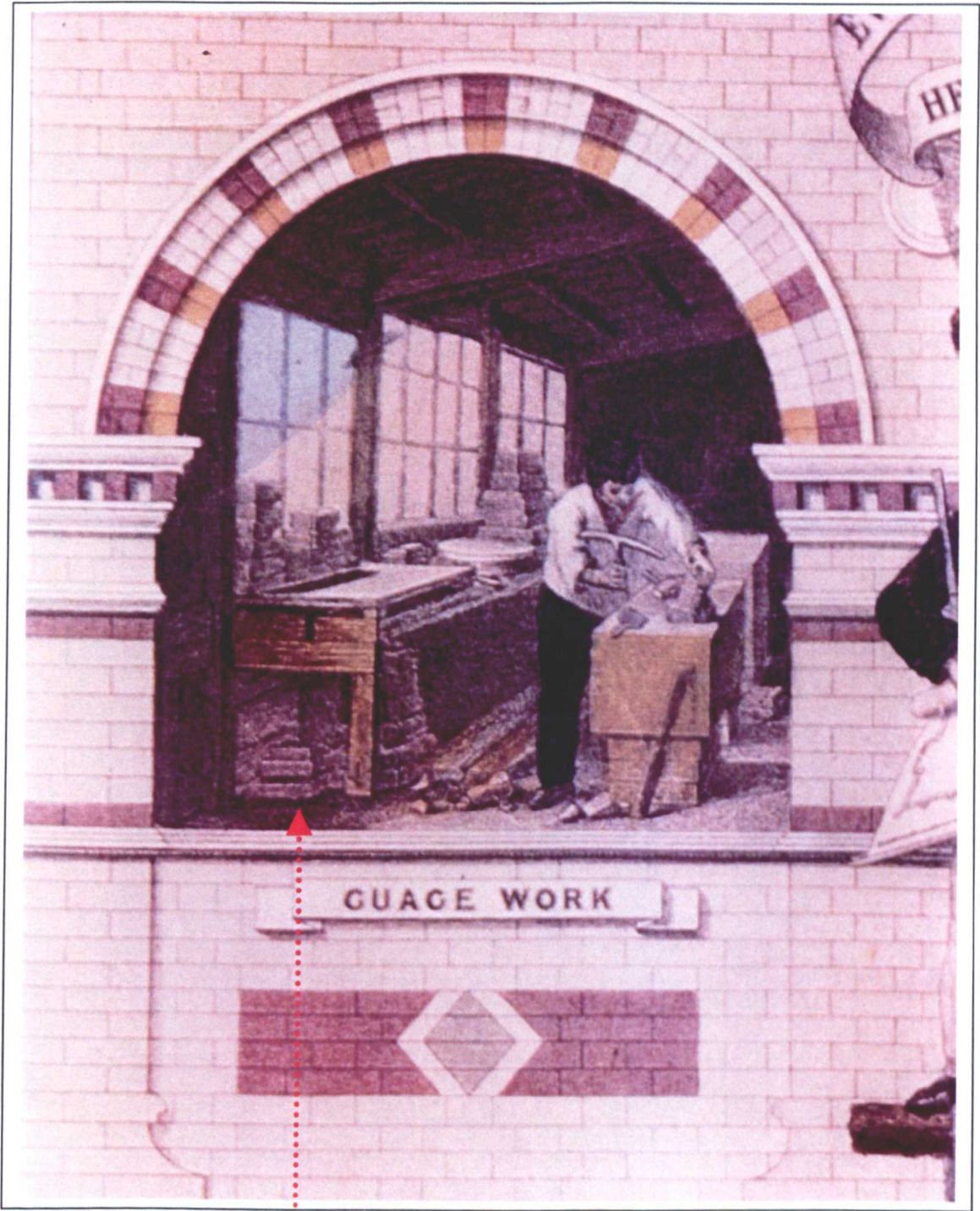
Of interest is the size of the brick axe in comparison to the other bricklayer's tools at the bottom of this certificate.

xiii (Figure 74) *The Operative Society of Bricklayers Emblem*, by A.J. Waudby, 1869 (*The People's History Museum, Manchester*).



Once again one can gauge the size of the brick axe from its depiction in the cutting shed, in the hand above the armorial shield and at the bottom of the emblem, alongside the other bricklayer's tools.

xiv (Figure 75) Large brick axe lies against the chopping block in A.J. Waudby's 1863 depiction of a cutting shed.



Profiled cutting boxes above and below the bench, which holds the rubbing stone and bedding slate

xv (Figure 76) Depiction of a cutting shed, where two cutters are preparing gauged voussoirs and dry-bonding gothic arches, the large brick axe again lays against the chopping block, by A. J. Waudby, 1869 (The People's History Museum).

